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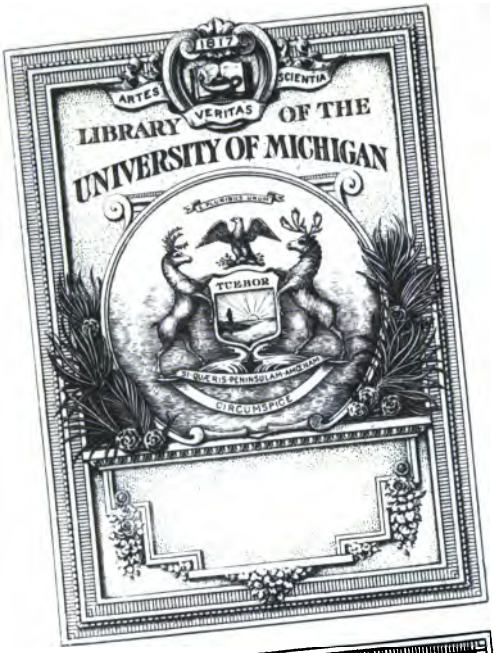

THE GIFT OF

Mrs. George S. Morris

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QH
48
.M86

Ethel C. Morris.

With Mrs Aug K's love.

March 31st 1892.

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A SONG OF LIFE

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A

SONG OF LIFE

BY

MARGARET WARNER MORLEY

ILLUSTRATED BY THE AUTHOR
AND ROBERT FORSYTH

CHICAGO
A. C. McCLURG AND COMPANY
1891

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A SONG OF LIFE.

FLOWERS.

WE all love flowers. Most of us love them as we love jewels and sunshine and color; they gratify our love of beauty and by their presence make us happier. But some have a deeper reason for loving them; to them the flowers are one expression of that life of which man is but

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another expression. They do not think of man as something apart by himself, but rather as a part of the universal life which the plants and birds and all living creatures share with him. Their eyes and hearts are open to the sister life in the world about them, and they look at the flowers, not only with pleasure, but with the love which recognizes in them a sweet though simple existence like our own. Most of us ignore the tie which binds us to the plant as well as to our human brother. In this respect we are like him of whom it was said, —

> "A primrose by the river brim
> A yellow primrose was to him,
> And it was nothing more."

And yet the primrose *is* something more than a bit of yellow on a green background; it has *life*, and in many important respects life in the plants is the same as life in us. That which is necessary to our existence

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is also necessary to theirs. But not all of us have stopped to think about this. We pride ourselves upon possessing what we call the breath of life. We consider ourselves vastly superior to the humble plant in this respect. We show in our literature, in our conversation, and in many other ways, how highly we esteem our power to breathe. But the plants breathe too. They do not boast about it, but they do it. All know that the air is composed of a mixture of oxygen and nitrogen gases, with more or less watery vapor and a very little carbonic acid gas, and that oxygen is necessary to life, while nitrogen, which forms four fifths of the atmosphere, merely serves to dilute the oxygen.

Animals breathe air into the lungs, the lung-cells take oxygen from it and throw back into it carbonic acid gas, which is an impurity. Plants use air in the same way, but as their lungs consist of cells

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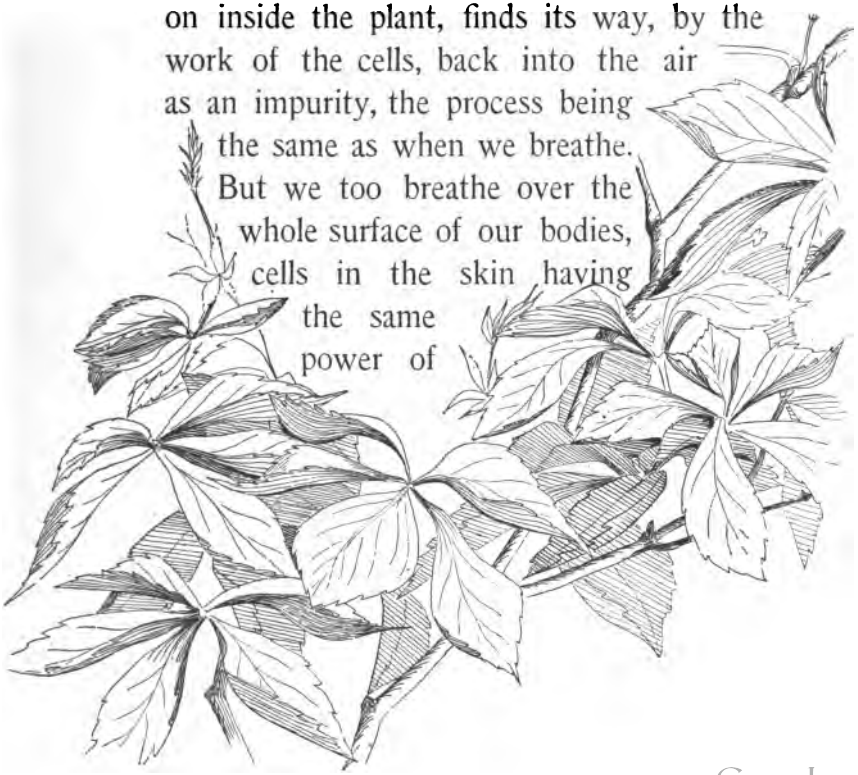
which cover all their leaves, the plants breathe over the whole surface of their bodies. As the air bathes them, the plant-cells, eager for oxygen, seize upon it and compel it to leave the air and join them. From them it is transferred to the other tissues that need it, and the carbonic acid gas set free by the chemical work going on inside the plant, finds its way, by the work of the cells, back into the air as an impurity, the process being the same as when we breathe. But we too breathe over the whole surface of our bodies, cells in the skin having the same power of



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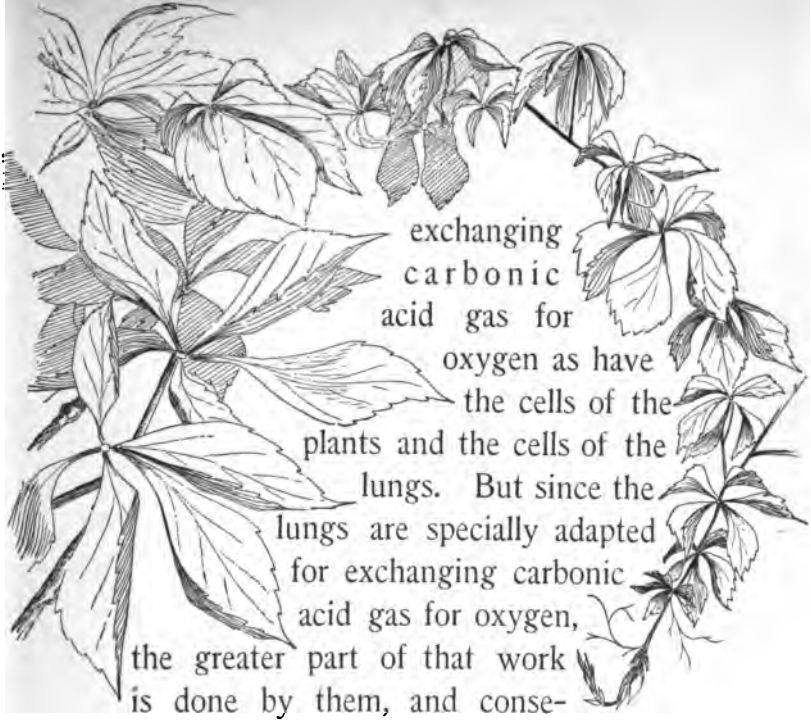

quently we think of the lungs as the only breathing organs until somebody reminds us that we breathe all over our bodies, like plants.

And plants eat. Not such gross food as we take, for they are dainty feeders upon things too fine for us even to taste. Down in the ground the roots creep about among the rocks and soil, and drink in the moisture and the gases and other mineral elements there, and this food they

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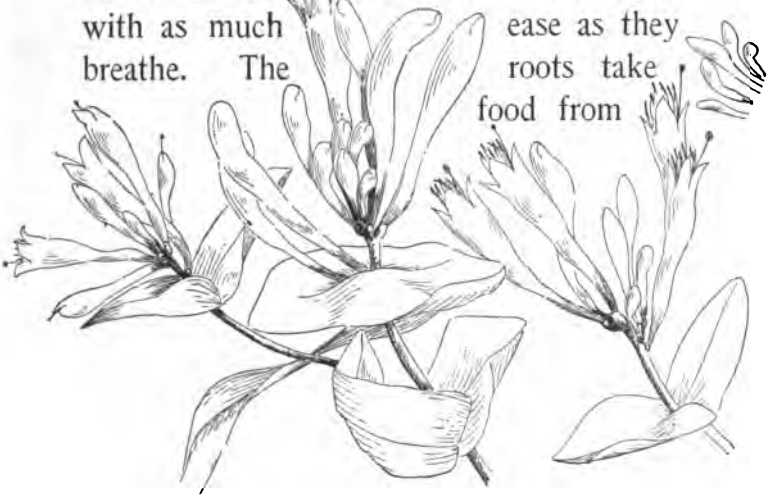
send up the stem in spite of the force of gravity, whose business it is to pull everything down. Thus are fed the stems and leaves and flowers, for as the fluid food passes along, touching every part of the plant, each tissue draws to itself the material it needs for building new tissue or rebuilding that which is worn out. In this way the plant grows. But the roots do not supply all the food, for the leaves feed too, — taking in nourishment over their whole surface, feeding generously wherever air and light touch them. In fact, the leaves absorb food with as much ease as they breathe. The roots take food from



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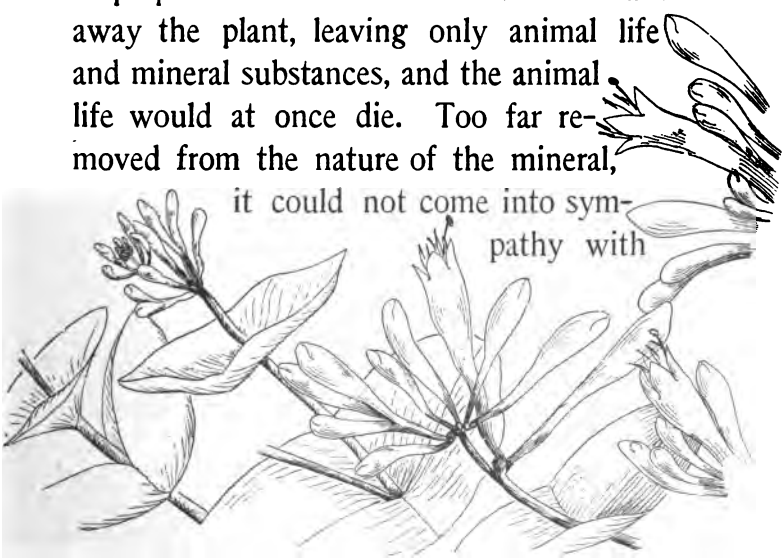
the soil; the leaves take it from the air, for the plant feeds upon the elements which make up the air and the earth, combining them in various ways, and finally converting them into its own living substance. In this way it grows and becomes food for animals.

Its power to change mineral matter into living substance is so important that without it there could be no life on earth. The plant is the chemical laboratory in which is prepared the food of the world. Take away the plant, leaving only animal life and mineral substances, and the animal life would at once die. Too far removed from the nature of the mineral, it could not come into sympathy with



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it, — it could not give life to the rock; it could not transform the mineral's cold matter into its own living tissue; it would starve to death. Now introduce the plant. Modest yet full of power, it stands at the border-land of life. On one side is the lifeless mineral, on the other the helpless animal. The plant, with its humble life, reaches down to the mineral, — touches it with a living touch; and the mineral, otherwise lifeless forever, responds to the touch of the plant, shares its life, and becomes a part of it. Thus provided with abundant living material, the plant yields nutriment to the life above it; so that every animal, including man, is dependent upon plant-life for its existence. All animals feed upon the plant; remotely, it may be, as when one animal feeds upon another, yet ultimately, the plant is the source whence comes the material for the animal form. The plant exists by creating life; the animal by destroying it.

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In still another way plant-life renders animal-life possible. Plants consume carbonic acid gas as food. They take it from the air in large quantities, and thus clear the atmosphere of a dangerous element, for a small amount of carbonic acid gas renders air unfit for animals to breathe. The plants, therefore, live upon and convert to a good use the waste of breathing, which might otherwise accumulate in sufficient quantities to be dangerous to the higher life. But this is not all. When carbonic acid gas has been taken as food the plant tissues use the carbon, but the oxygen, which forms a part of carbonic acid gas, they reject and send back to the air, thus giving to animals the oxygen, which is necessary to their lives, and taking away the carbonic acid gas, which is fatal to life.

The breathing and feeding of plants are so easily confused that it may be well to insist that they are two entirely different

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functions. Plants breathe out carbonic acid gas and take in oxygen just like animals; so inasmuch as they breathe they render the air impure. They eat carbonic acid gas and throw off oxygen as a waste, so, inasmuch as they eat they purify the air. The products of feeding are much greater than those of breathing, very much greater, so that plants are powerful purifiers of the air and keep it fit for animals to breathe. During the flowering season, however, the plant is less active as a purifying means, and in cases where there is a great mass of bloom may even belong to the destructive forces, vitiating more air than it purifies; for, the flowers, being so fragile and perfect and not obliged to grow, feed little and breathe much. That is why some people consider them unhealthful in a sick-room, — the flowers breathe the air which the patient needs.

Besides breathing and feeding, plants reproduce themselves. Like higher forms

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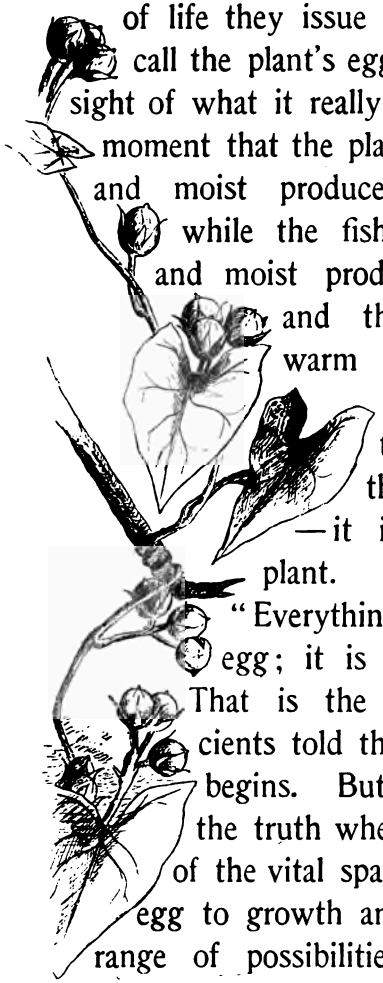

of life they issue from the egg. We call the plant's egg a seed and so lose sight of what it really is; but recall for a moment that the plant's seed kept warm and moist produces a young plant, while the fish's egg kept warm and moist produces a young fish, and the bird's egg kept warm and dry produces a young bird, and the true nature of the seed is apparent, — it is the egg of the plant.

"Everything springs from the egg; it is the world's cradle." That is the way the wise ancients told the secret of how life begins. But they told only half the truth when they said nothing of the vital spark which kindles the egg to growth and adds to it a new range of possibilities. Like them, we

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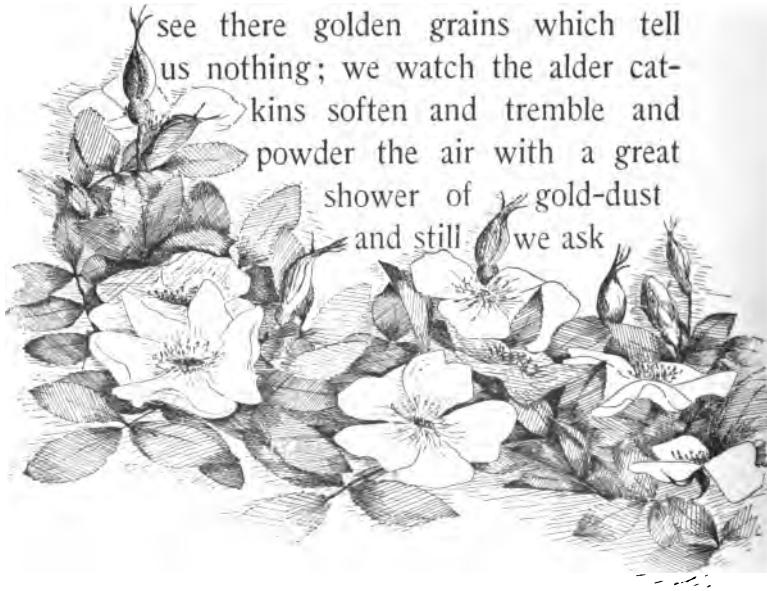
commonly fail of due reverence for paternal life, and attribute the miracle of regeneration wholly to the power in the egg. Walking through the fields in the autumn, we wade waist-high through a patch of golden-rod. As we jostle the stately plumes, out pours a cloud of fine yellow powder which settles upon our clothes like dust. We carelessly brush it off and pass on, not giving it another thought. We look into the heart of the rose and see there golden grains which tell us nothing; we watch the alder catkins soften and tremble and powder the air with a great shower of gold-dust and still we ask



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no question; we see the white temple of the Easter lily marred by the copious yellow dust which falls from its anthers; we are powdered by the evening primrose. In fact, in nearly every flower we know, we find the pollen-powder, the dust of the flowers. And we are indifferent to it, seeing it all our lives, until one day we ask what it is and discover to our wonder that it has much to do with the life of the plant, and that the seeds which are hidden in the hearts of the flowers owe their development to it. There are many things in the life of the plant worth knowing, but of all the wonderful facts of plant-life which man has discovered, nothing is stranger or more beautiful than what is known of the dust, or pollen, of the plant, and of its ovules, or seeds.

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Even though every one may know the truth concerning the pollen and the ovules, their story, like all the best stories in the world, will bear telling a great many times; and this time it is one link in a chain of great meaning which begins in the plant and passes through all other life, until it ends in man, binding all life together in close bonds of relationship.

But before going so deeply into the secrets of plant-life as the story of the pollen would lead us, we shall have to consider a number of facts, just as one is obliged to cut through a mass of fibre to reach the kernel of the cocoanut. The first fact shall be a seed. We will examine one to set us thinking.

From the morning-glory vine we pluck a ripe, brown seed-vessel. Carefully opening it we find three little silky nests, in each of which are two seeds. Very delicately removing the outer skin from one of these seeds we find inside a green

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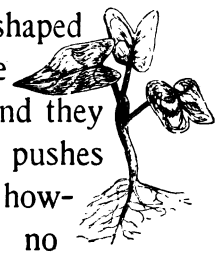
core covered with a clear, jelly-like substance. (If the seed is hard and dry, it should be soaked in warm water for a few minutes before examination.) We next

remove all of the outer covering and the jelly-like substance and spread out the green core. It seems to be a tiny leaf. Examined more carefully it proves to be two leaves lying close together and having at the point of union a tiny bud-like root. In fact there is a whole plant thus skilfully packed away in the little hard seed. Plant the seed, and the young morning-glory will issue forth. The first leaves that appear above the ground are different from the later, heart-shaped leaves; they are the two blunt little absurdities we found in the seed, and they push up to the light while the root pushes down into the soil. The next leaf, however, is heart-shaped, and bears no resemblance to the seed-leaves, whose duty it was to be as compact and sturdy as



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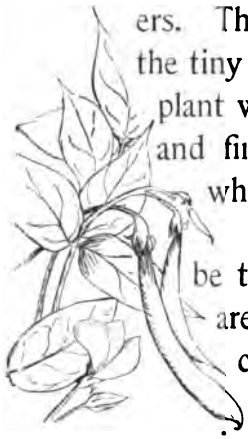
possible in order to start the plant. Being now fairly started, the plant grows rapidly until it is a full-sized vine and bears flowers. Thus it would seem that in some way the tiny seed held the idea of the perfected plant within its walls. Open a bean pod and find the seeds there, each in a soft, white nest.



Take one of the beans and let it be the seed we next examine, for we are in no hurry and may as well become acquainted with seeds while we are in the mood for it. Again removing the outer skin, which in this case is leathery and white, we find no jelly-like substance. The bean seems split into two fleshy parts, and at their point of union is a tiny sprout consisting of two leaves folded close together. Plant the bean and the sprout grows. The two little yellow atoms of leaves become large and green, and a root strikes down into the ground. After a time

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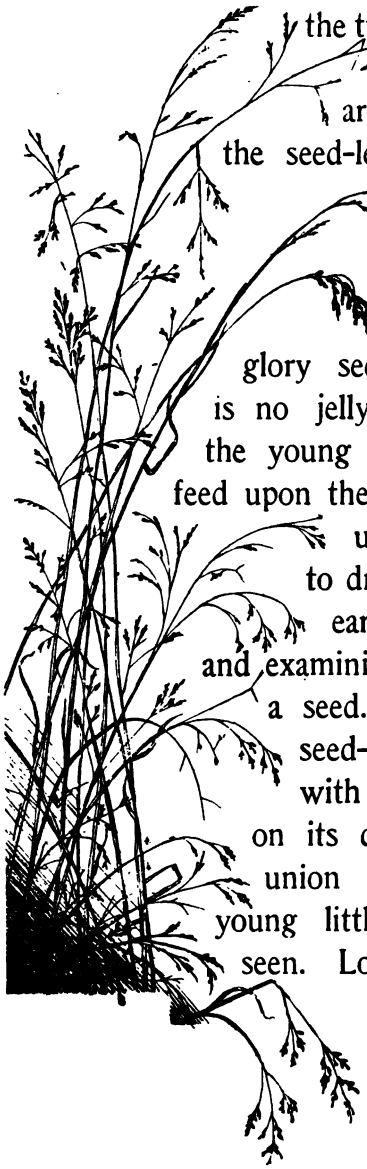

the two fleshy parts turn green; we find they are veined, and in fact are the seed-leaves, which were packed full of starch to start the young plant. They are larger and fatter than the morning-glory seed-leaves, because there is no jelly-like food packed about the young bean plant, and it must feed upon the starch in its seed-leaves until it is strong enough to draw nourishment from the earth. Opening a peanut and examining the meat, we find it a seed. The part we eat is the seed-leaves, stored with food with which the plant may start on its career. At the point of union of the seed-leaves, the young little plant may be plainly seen. Looking into a squash seed

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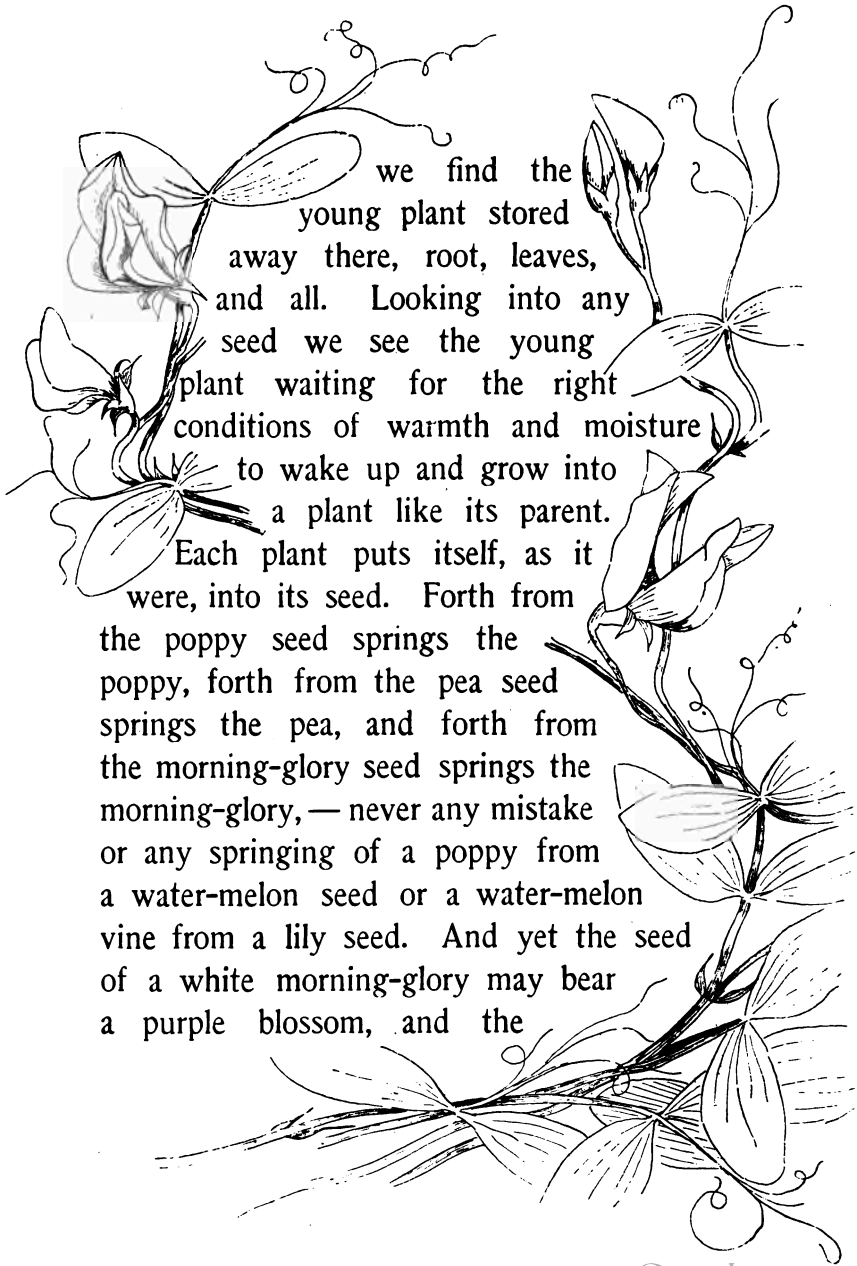

we find the young plant stored away there, root, leaves, and all. Looking into any seed we see the young plant waiting for the right conditions of warmth and moisture to wake up and grow into a plant like its parent. Each plant puts itself, as it were, into its seed. Forth from the poppy seed springs the poppy, forth from the pea seed springs the pea, and forth from the morning-glory seed springs the morning-glory, — never any mistake or any springing of a poppy from a water-melon seed or a water-melon vine from a lily seed. And yet the seed of a white morning-glory may bear a purple blossom, and the

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seed of a red verbena may bear red-and-white blossoms. If we grow white flowers and red flowers of the same species together, their seed will be apt to give us red-and-white flowers. Our petunia seed will not "come true" if two or more colors are grown together, but the seeds of the white petunias will yield purple and white flowers, or red and white ones. The flowers will in fact be apt to be striped or spotted by the colors of all the petunias in the garden. Flowers seem to have some strange influence over each other which causes their seed to inherit the peculiarities of neighboring plants of the same species. In order to understand this strange habit we will pass from the seed, which has thought-matter enough to to last us a lifetime, and will question the pollen. But first we shall be obliged carefully to examine a flower. The morning-glory blossom will answer the purpose very well. Its most showy part, the

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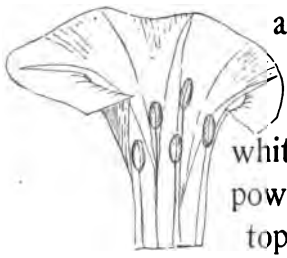
bright-colored bell, or corolla, as it is technically called, surrounds delicate inner organs. The first set of these organs grows fast to the bottom of the corolla,



and when the corolla is pulled away they come too. They are the *stamens*, and have a delicate white filament, or stem, with a powder box, or *anther*, at the top. Each anther has two cells, and these cells hold the pollen. When the anther is ripe the cells split open and let the pollen fall out. The pollen being the essential part of the stamen, the stamens of some kinds of flowers have no filaments. The pollen every flower must have if the plant is to bear seed, but that is the only part of the stamen that is absolutely necessary.

When corolla and stamens were pulled away from the morning-glory, but a seemingly unimportant part of the flower was left. This central column, however, is

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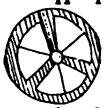
of the greatest value, for it is the *pistil*, and at the base of the pistil, in its thick, round bottom, is the seed-case, or *ovary*. A slender white column, the *style,* rises from the ovary and is topped with a round, ball-like *stigma.* The ovary and stigma are the necessary parts of the pistil, the style is only a passage-way from one to the other, and some flowers have no styles. Ovary and stigma every flower must have if it is to bear seed. If the morning-glory ovary be cut across, six little seed-like bodies are seen embedded there. These are the ovules, and would one day have been the seeds if the pollen had done its duty and the flower had not been disturbed. But the ovule is not the seed. No ovule alone could become a seed. It would seem as though the plant were not content with what its one life could give, as though it longed to reach out and touch other life



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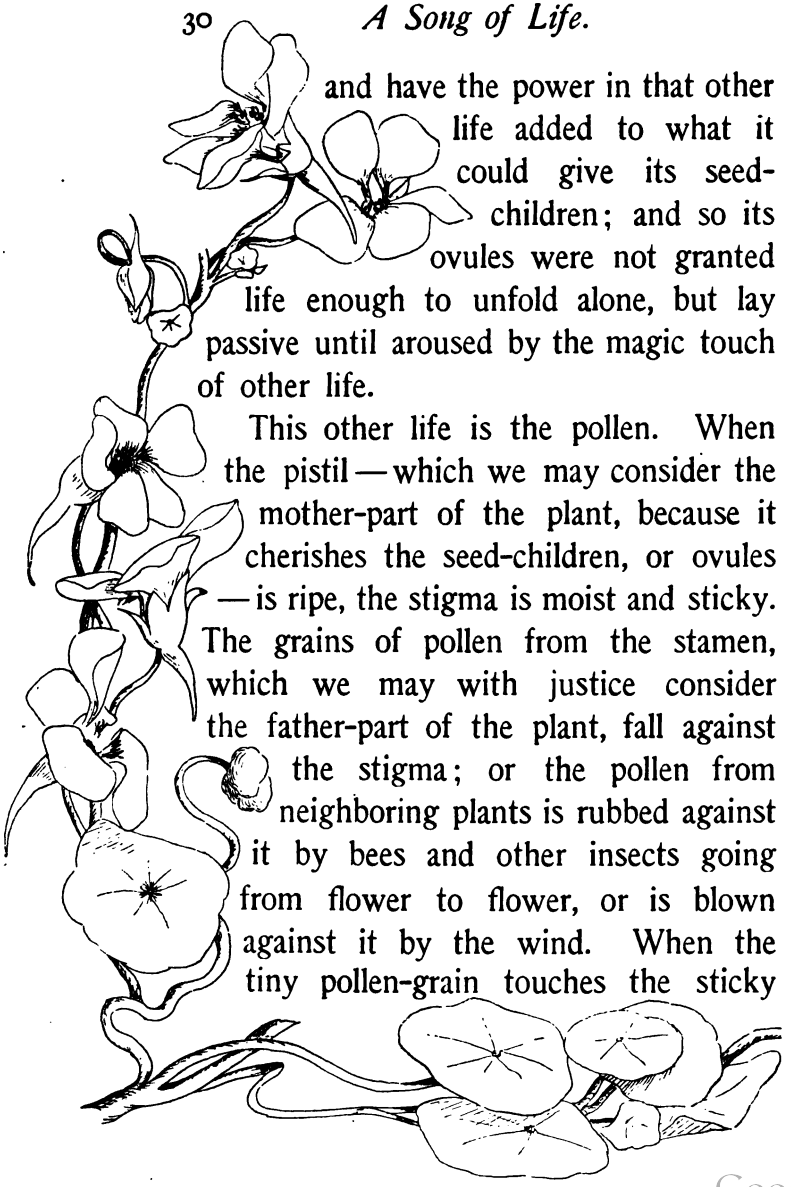

and have the power in that other life added to what it could give its seed-children; and so its ovules were not granted life enough to unfold alone, but lay passive until aroused by the magic touch of other life.

This other life is the pollen. When the pistil — which we may consider the mother-part of the plant, because it cherishes the seed-children, or ovules — is ripe, the stigma is moist and sticky. The grains of pollen from the stamen, which we may with justice consider the father-part of the plant, fall against the stigma; or the pollen from neighboring plants is rubbed against it by bees and other insects going from flower to flower, or is blown against it by the wind. When the tiny pollen-grain touches the sticky

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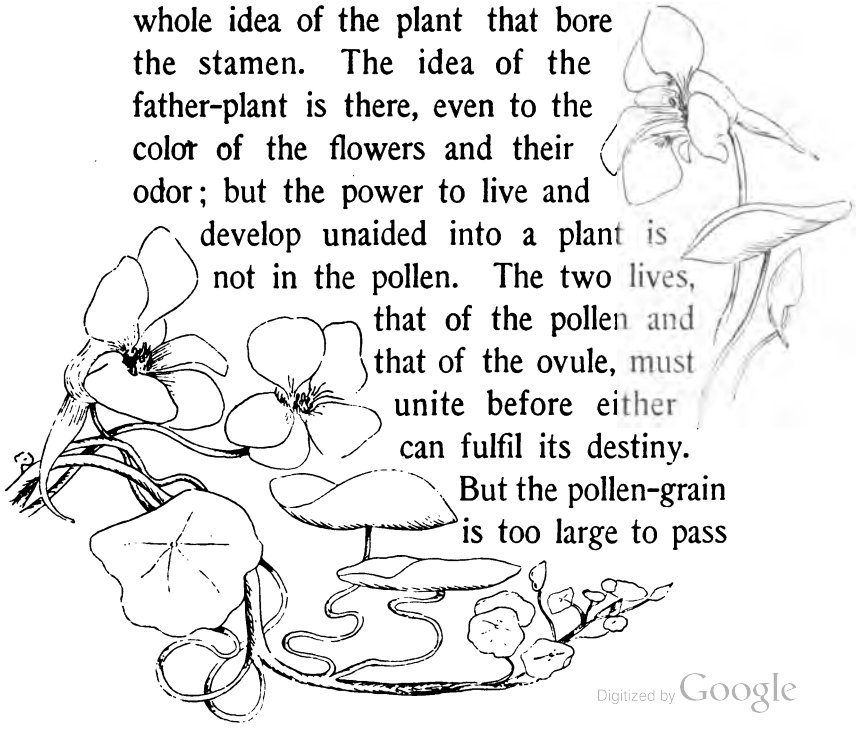
stigma it is held fast. The pollen-grain, which in most kinds of plants is so small that to see its shape one needs a microscope, is nevertheless a sac filled with oil and other substances, and containing two or more *very small* living bodies. In these living bodies, strange as it may seem, is the life the ovule must add to its own before it can become a seed. In these microscopic atoms, too, is contained the whole idea of the plant that bore the stamen. The idea of the father-plant is there, even to the color of the flowers and their odor; but the power to live and develop unaided into a plant is not in the pollen. The two lives, that of the pollen and that of the ovule, must unite before either can fulfil its destiny. But the pollen-grain is too large to pass



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through the stigma and work its way down through the loose tissue of the style to the ovary. Contact with the moist stigma has, however, caused it to swell, and soon one part of it is seen dipping down into the stigma like the finger of a glove. This part continues to lengthen, forming a long tube which finds its way down through the style to the ovary. The living essential atoms in the pollen-grain slip down the lengthening tube, and when the little tube finally enters the ovary the little living bodies break through the delicate wall of the tube and enter the ovule. One can see in the cut how it is done in the pistil of the buckwheat, which has three stigmas. In other flowers the process is essentially the same. As soon as the pollen atom has joined, or to speak scientifically, fertilized, the ovule, a change takes place. The ovule enlarges and has formed within it the tiny plant we see in the

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seed. The ovule, in some wonderful way, contains within its tiny walls the whole idea of the mother-plant. Through it can be transmitted any or every peculiarity of the mother, if the pollen touches it to life. But the pollen can also transmit any peculiarity of the father-plant if the ovule touches it to life. The red verbena has the red ideal in its ovule and in its pollen. The white one has the white ideal. If a bee, in passing from the red to the white flower, should bear grains of pollen from one to the other, the stigma of the white flower would eagerly receive the pollen of the red; and thus the seed so produced would be rich in color-life, and might bear a flower either red or white or both red and white.

The power of life seems stronger where new elements join; and for this reason fertilization from another plant, or as the botanists say, cross-fertilization, as a rule produces stronger plants than self-fertiliza-

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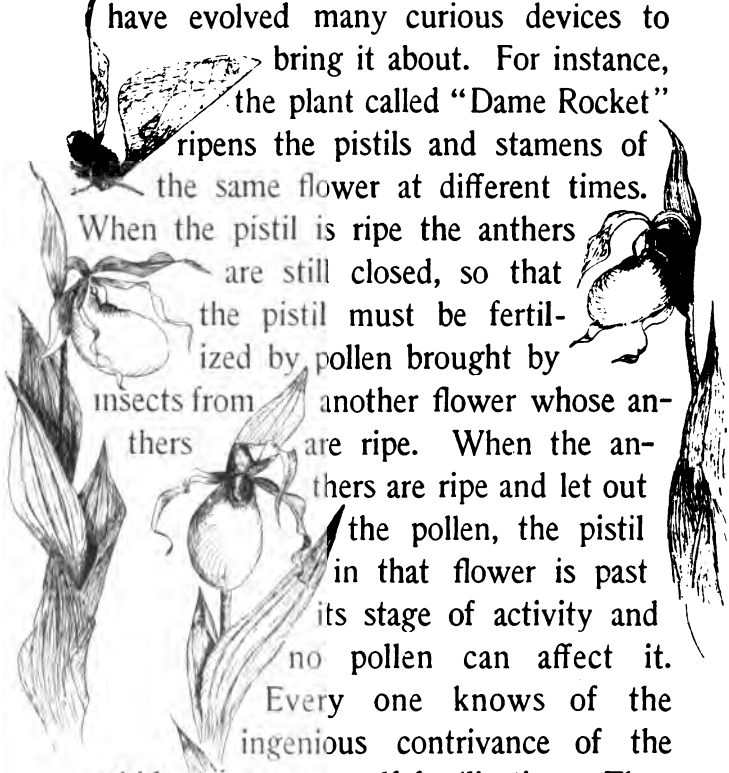
tion; and so keenly is this cross-fertilization desired by the flowers that they have evolved many curious devices to bring it about. For instance, the plant called "Dame Rocket" ripens the pistils and stamens of the same flower at different times. When the pistil is ripe the anthers are still closed, so that the pistil must be fertilized by pollen brought by insects from another flower whose anthers are ripe. When the anthers are ripe and let out the pollen, the pistil in that flower is past its stage of activity and no pollen can affect it. Every one knows of the ingenious contrivance of the orchids to prevent self-fertilization. They have but two stamens, and their pollen-grains are fastened together by threads



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like fine spider-web, so that the whole mass of pollen keeps together. The stamens are so placed that the pollen cannot fall upon its own stigma, but the honey sac is so situated that when Sir Moth puts his head into Madame Orchid's honey pot he touches the sticky pollen masses and bears them away, one attached to each eye. Being fond of Orchid honey he hurries off to call on another flower, for where one grows more are not far off, and as he finds his way to the nectar sac the pollen on his eye touches the sticky stigma and is left there, while he gets a new supply to take to the next flower. Thus he becomes the bearer of new life, and peoples the woods with future orchids.

The pumpkin has settled the manner of fertilization most emphatically. All of the stamens are banished from the blossom that bears the pistil, and no pistil is found in the one that holds the stamens. The pumpkin will be cross-fertilized or not at

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all. The begonia is sometimes still more exacting, and has all the flowers upon one plant. staminate flowers — that is, flowers bearing only stamens — and all upon another plant pistillate flowers.

Some nut trees have the same habit, and this is why one tree will always have nuts and a companion tree never. Cut down the apparently useless tree and there will be no nuts on its neighbor, for half the life of the nuts came from the nutless tree. Maples and elms have the stamens and pistils in separate flowers. The anthers hang out on long thread-like filaments, dressing the tree in dainty fringe, and pollen is scattered in light abundance on the wind, which blows it from flower to flower.

The pine-tree pours such a wealth of pollen into the air in trust for its cones, where the seeds lie, that it is carried for miles and forms a yellow scum on the neighboring ponds. The grasses dust the

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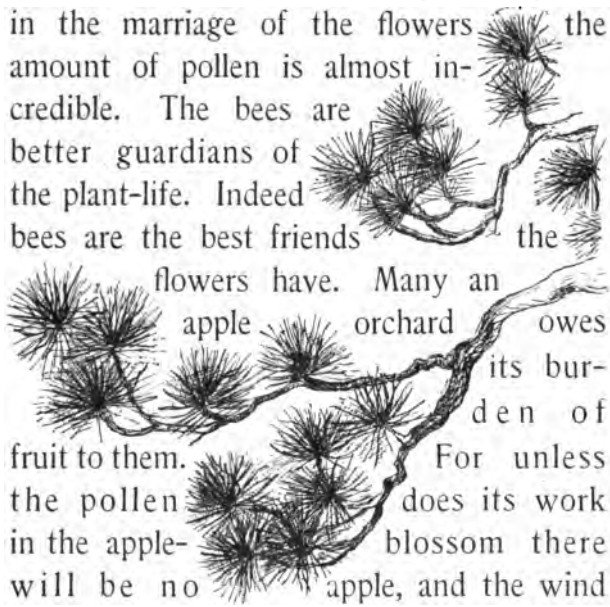
air with every breeze that blows. Wherever the wind is to act the part of priest in the marriage of the flowers the amount of pollen is almost incredible. The bees are better guardians of the plant-life. Indeed bees are the best friends the flowers have. Many an apple orchard owes its burden of fruit to them. For unless the pollen does its work in the apple-blossom there will be no apple, and the wind is a fickle helper. The clover keeps its pollen stored away where the wind cannot reach it, and relies upon the bumble-bee to convey it from flower to flower. Unless a flower is fertilized, it will wither and fall and leave no trace of its existence. The ovule has seldom power to become a



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seed unaided by the pollen, and it is for the sake of the seed that the fruit forms, so we owe our apples and peaches and other fruits to the pollen, as well as to the ovary.

The essential organs, stamens and pistil, are so wonderful in structure and beautiful in form, and are the authors of so many ingenious contrivances to insure fertilization and the scattering of seed, that one cannot look intelligently into the commonest flower without being filled with admiration. The thistle is a revelation and the burdock a psalm. The ovary of the orange is a globe of nectar; and the cherry ovary, fortunately for the birds and us, is a rich, juicy

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pulp. The ovaries of the strawberry are perched upon a pyramid which is delicious in flavor and delightful in fragrance. The fruit of the dandelion flies away on wings of down. The stamens of the blue flag are hidden away, and the anthers of the wintergreen open by a single little pore in the top of each cell. The mountain laurel has a romance well worth the reading.

The pollen-grains, often so small that to see them requires a microscope, are of strange and beautiful forms. The musk-plant has them spherical and beautifully grooved. In the star-cucumber they are again spherical but marked in a peculiar manner which makes them different from all other pollen-grains. In the hibiscus we find again spherical pollen-grains, but covered with little points. In the mountain

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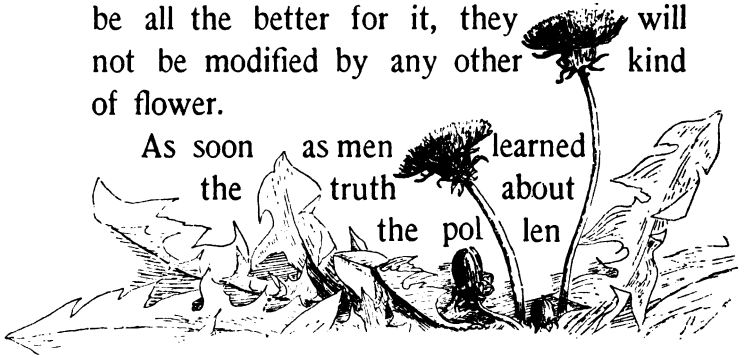
laurel they are like several spheres fastened together. In the evening primrose they are three-sided. In the milk-weed they are attached to each other in masses, like those of the orchid, and form two pear-shaped bodies. And yet, though each grain of pollen is full of dormant life, its life responds only to a life akin to its own. The pollen of a hawthorn blossom, active at once in the ovule of any other hawthorn, is powerless upon the stigma of a stranger plant. It cannot fertilize a lily, it cannot fertilize a sweet-pea. It can continue to live only when in union with its own kind; so though the verbenas will exchange colors with each other and be all the better for it, they will not be modified by any other kind of flower.



As soon as men learned the truth about the pollen

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and the ovules they naturally made use of their knowledge to produce modified forms which should gratify their tastes in various ways. And thus were originated many rare flowers and fine varieties of berries, grapes, and other fruits. Plant-life, like all other life, is mysterious; and the results of the union of any two plants cannot be foretold. The gardener having one variety of grape, fine in size and color but lacking in flavor, may fertilize its flowers with pollen from another variety, fine in flavor but lacking in color and size. When the vine raised from the new seed bears fruit, the fruit may chance to combine the good qualities of both parents, or it may be so unfortunate as to have inherited the bad qualities of both. Man, with all his pride of

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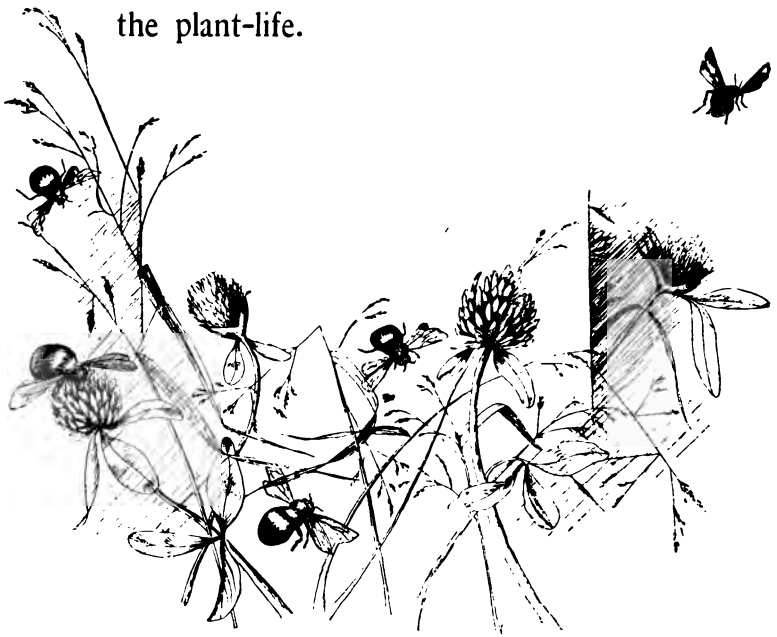
knowledge, cannot control or even infallibly foresee the action of life in that other life, akin to but different from his, the plant-life.



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FISHES.

In the water as upon the land, life is abundant. The things that live in the sea consider it but air diluted to suit their delicate organs; for the life in them is governed by the same laws that govern life out of the water. The land animal and land plant breathe oxygen diluted with nitrogen. Pure oxygen would intoxicate, consume them, burn them up, as effectually as if they had fallen into a raging furnace. Pure air would intoxicate, consume the creatures of the sea; their oxygen must be diluted with nitrogen, and their air with water. But air, in small quantities, they must have or die;

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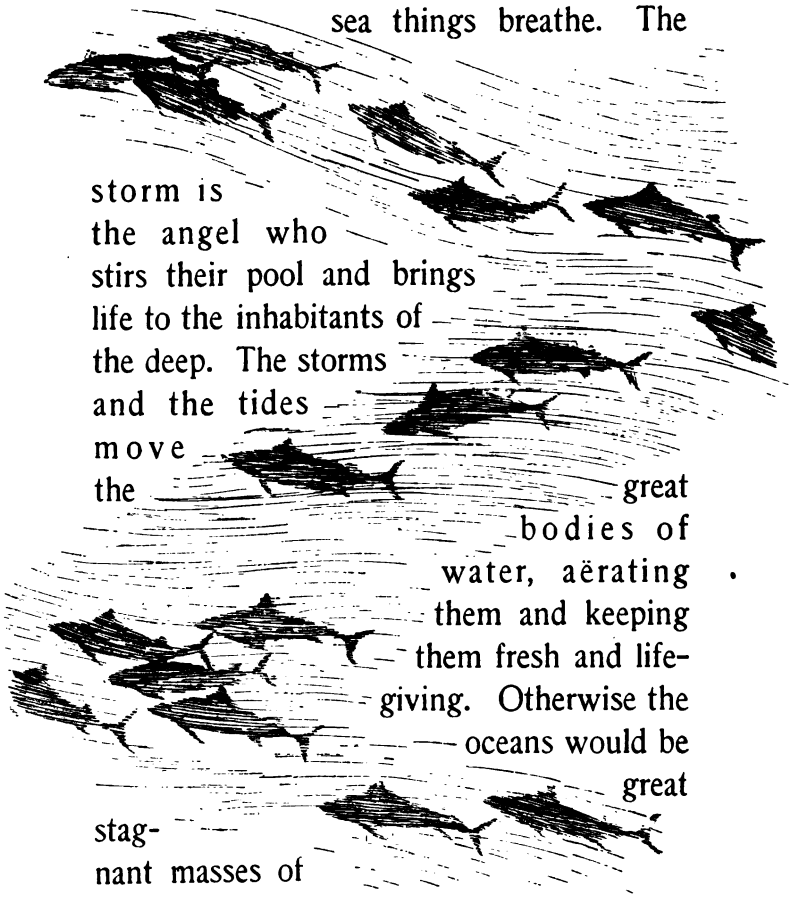
and there is air in the water which the sea things breathe. The storm is the angel who stirs their pool and brings life to the inhabitants of the deep. The storms and the tides move the great bodies of water, aërating them and keeping them fresh and life-giving. Otherwise the oceans would be great stagnant masses of death and decay which would speedily put



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an end to all the higher forms of life that now exist. But under the storm-purified waves there is carried on a life varied and wonderful. One who loves this water-life has thus told about his friends: —

"For warriors, lo! we have the fish known as the goby, who turns quite black with rage when he beholds his prey, and whose turquoise-colored eyes light up with fury as he dashes to the fierce encounter. We have, too, the graceful stickleback, who makes his nest like a bird, waits upon his mistress with all the gentle complaisance of the knight-errant of old, and enters the lists in his uniform of glowing scarlet trimmed with white and green, or deep, deep purple, to do battle for the object of his affections. The stickleback adores the tournament. In the heat of the conflict his gorgeous colors flash out intensely in their brilliance. Defeated, his war-paint fades into the dullest hues, or only flickers changefully up in his dying

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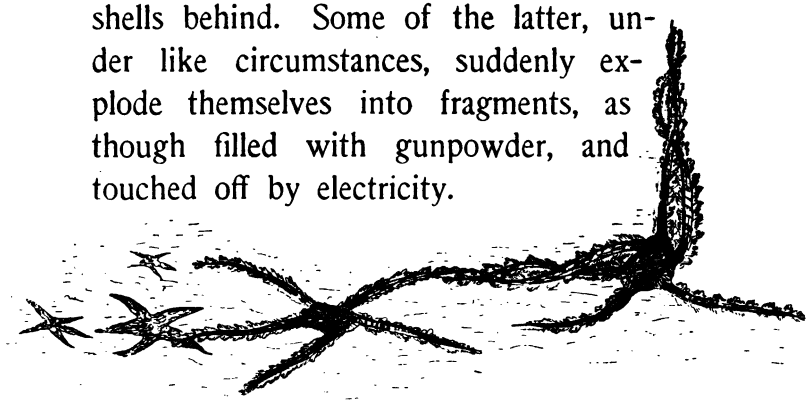
throes, as if in death he had a dream of victory.

"For ogres, we have the actiniæ, who, garbed in the seductive costume of the gayest flowers, lie in wait for thoughtless victims. Their delicate petals are a thousand murderous arms, prepared to grasp all of annelid life that may be tempted to embrace them, while every pretty crimson dot conceals a poisoned barb, which they project unerringly as death at passing infusoria.

"For sentimental performers, we have the sea cucumber and the starfish. Some of the former, when irritated, deliberately commit suicide by expectorating the whole of their intestines, leaving their empty shells behind. Some of the latter, under like circumstances, suddenly explode themselves into fragments, as though filled with gunpowder, and touched off by electricity.



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For beauties, we have the sea mouse, clothed in silken hair, and glittering in all the iridescent colors of the butterfly; we have the sea slug, covered with gem-like specks that may well pass muster for sapphires and emeralds; we have the minnow, the dandy of his tribe, with his vest of roses and his coat of olive green.

"For Jeremy Diddlers, we have the hermit crab, who pilfers a whelp shell for his residence; we have the nereis, who attaches himself, perdu, to the crab's doorway, and gourmandizes on all the food he can seize as it enters; and we have the cloak anemone, which insidiously mantles the two, and then devours all it can abstract from the mouths of both. To this category we might add the phyllodoce, who turn themselves inside out like a stocking, and when the inverted stomachs fill with passing pabulum, restore the sated organs to their original position.

"The comic actors on this stage of life

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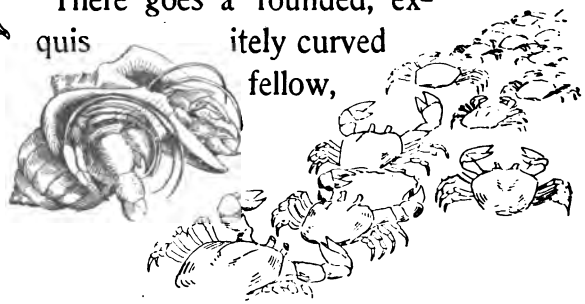
are too multitudinous for detail. The climbing frog and climbing crab are gymnasts of the first order; the rednose carries a natural syringe, with which he squirts water upon all who inconvenience him; the caddis worm sports a portable domicile of sticks and stones; the newt is alive with graceful evolutions, full of merry twists and laughable eccentricities."

Those who have visited the fish at home — that is to say, have stood before the glass tanks of a sea aquarium and watched their every-day life — will gladly place them close to the flowers in thought and affection.

There goes a rounded, exquisitely curved fellow,



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smaller than the palm of your hand and colored like mother-of-pearl. Suspended in the pure sea-water, he is worthy a place among Neptune's crown jewels; and when he moves words cannot be found to describe the beauty of his undulations. Near him is an Oriental aristocrat, brilliant as an ocean sunset, and with long, soft, floating fins and tail like the drapery of an Egyptian princess. The flowers are not more brilliant in color or more varied in form than are the fish in the various tanks.

Many, however, are more curious than beautiful, and odder forms than have come out of the sea to finish their lives in the aquarium never passed through an opium-eater's dream.

"You strange, astonished-looking, angle-faced,
Dreary-mouthed, gaping wretches of the sea!"
says Leigh Hunt.

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But the sea, the splendid, invigorating salt sea, does not hold all the fishes. They have gone up the streams into the land, and have peopled the lakes and ponds, wherever the conditions for fish-life were favorable. Every one has known, as a child, the minnows in the brooks, flashes of silver easy to catch; and also that bit of brightness in the ponds, rightly named the sunfish. The catfish, too, homely and ugly to deal with, because of his "horns," has made a lasting impression upon most country boys and girls.

Strange as the cold, unlifelike life of the fishes may seem to our different way of looking at life, they are true animals; and unlike the flowers, which are able to exist upon air and earth, demand for their nourishment food which is the result of some other life. In fact, their appetite for living food is something to be regarded with amazement

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and consternation by creatures like ourselves, unable to look at cannibalism and the eating of live victims from the fish's point of view.

They do not absorb nutriment over the whole surface of the body, as is the dainty habit of the flowers, but have a distinct receptacle for their struggling meals, which they pursue and capture and consign to a laboratory which quickly reduces them to an elementary form of animal substance; for in the stomach of the fish its food is saturated with digestive fluids which change it into a liquid material which can be dissolved and absorbed into the blood. The blood carries the new material to all parts of the body, and each tissue, as this liquid food hurries along, takes from it the materials it needs to build or rebuild; so ultimately the fish disposes

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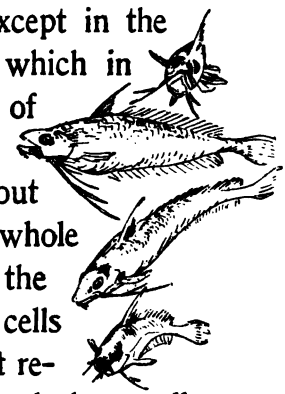
of its food in the same way that the plant does, only the plant-food, being already in a soluble state, does not need the services of a stomach.

The breathing of the fish, too, is the same as that of the plant, except in the smaller amount of surface which in the fish serves the purpose of lungs. No doubt the fish takes in oxygen and casts out carbonic acid gas over the whole surface of its body, as does the plant; but in the fish certain cells are much more active in that respect than are any others; and these cells are situated in the gills, where the air-laden water constantly bathes them. The oxygen in the air is seized by these gill-cells, and passed along to the tissue that needs it, while the carbonic acid gas, which has been formed by the chemical changes going on in the animal, is sent by the gill-cells out into the water.



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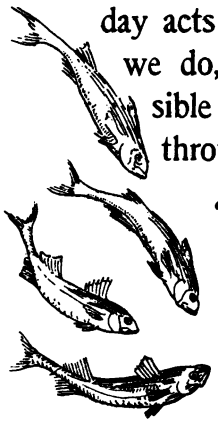
Interesting as pulling fish out of the water, with a hook in their gills and death in their hearts, is found to be by some, it is nothing compared to the delight of watching them at home, full of life, — familiar yet strange life, — doing the every-day acts of feeding and breathing that we do, and moving with an inexpressible charm, akin to that of flying through the cool waters.



"The fish is swift, small-needing,
vague yet clear, —
A cold, sweet, silver life, wrapped
in round waves,
Quickened with touches of trans-
porting fear,"

says Leigh Hunt, doing exquisite justice to his now dainty subject.

And life is in the fish. Life, whatever that is, resides in these creatures, which are more like animated crystals than things of flesh and blood. And life in them renews itself as it does in the flower.

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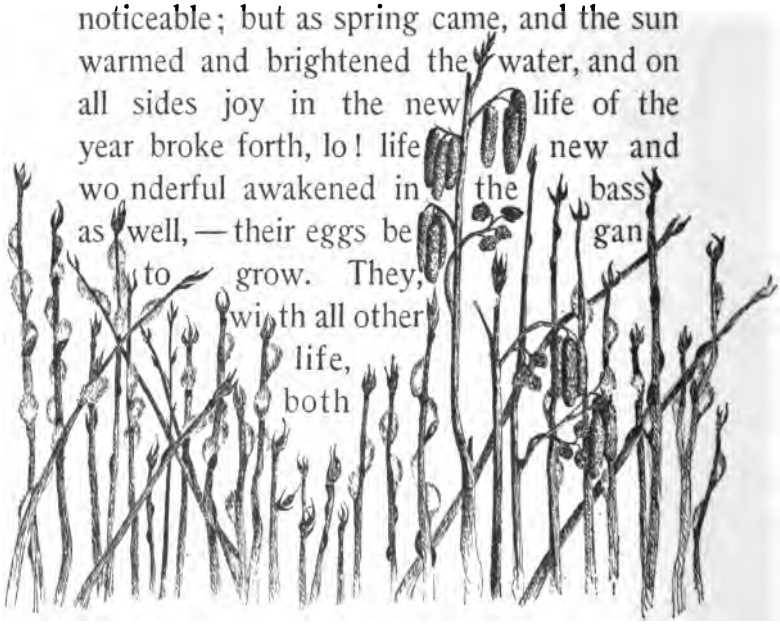
In the Wisconsin lakes live numbers of black bass. They are not so handsome as the scup or the golden perch, but are easy to watch, and are full of affection for their offspring. Early in the spring, inside the female bass, as at the right season is true of all female fish, there lay two long, broad bags of tiny eggs, one in each side of the body. During the winter, both eggs and bags were so small that they were scarcely noticeable; but as spring came, and the sun warmed and brightened the water, and on all sides joy in the new life of the year broke forth, lo! life new and wonderful awakened in the bass as well, — their eggs began to grow. They, with all other life, both



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plant and animal, responded joyfully to the warm caress of spring. In the swamps the willow-stems grew crimson and gold, showers of catkins swung from the alders, and the silver "pussies" peeped from their nut-brown coats. All over the fields the buds grew large upon the trees and the dry twigs changed and looked alive, as a delicate indefinable color crept over them. Not a leaf to be seen, yet all Nature glowed in anticipation of the joyous life soon to unfold. And everywhere the fish, too, leaped for joy, and their eggs grew. In the Northern lakes the bass, with numberless fresh-water companions, felt the stirring of new life. Everywhere in the ponds the little fish were filled with the joy of existence. At the great river mouths, where icy water sweeps from the regions of snow out into the open sea, the salmon leaped up the cold current, eager for the fresh-water pools, where their offspring were to come to a life of their own. Out

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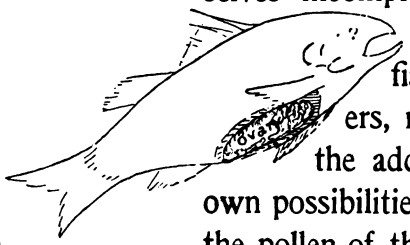
in the Gulf Stream the young eggs of the skate took shape and became the purses with clinging tendrils to anchor the quaint cradle with its baby to the weeds at the bottom of the sea.

Everywhere — in the sea, the rivers, the lakes, and little ponds — the fish had felt the stirring of life and the eggs grew. They grew until, in the ordinary fish, they filled a large part of the body cavity. The sac which holds these flower-seeds of the deep is the ovary, and the eggs themselves the ova. The eggs grow until they are ripe and ready to be deposited in the water. But these flower-seeds, these ova, are in themselves incomplete; they have not enough of life to perfect the future fish; they, like the true flowers, need the touch of other life, the adding of new power to their own possibilities. And this life, like that in the pollen of the flowers, grows as the eggs



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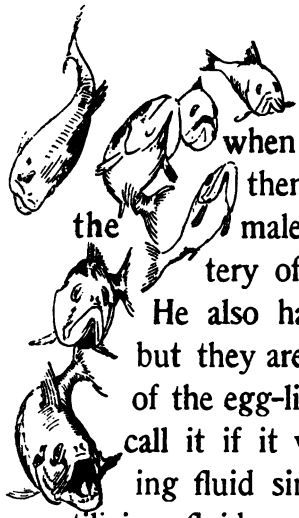

grow, that it may be ready, when the time comes, to join them. As spring draws near, the male fish, too, feels the mystery of life stirring within him. He also has sacs like the egg sacs, but they are filled with the other half of the egg-life, the pollen, as we should call it if it were a flower, the fertilizing fluid since it is a fish. This fertilizing fluid contains numberless minute living bodies, transparent as glass, delicately formed, full of motion and beautiful to look at, though they are so small as to be invisible except through the microscope. During the winter these sacs, like the ovaries, were small; but they grew with the spring, and the owner of them was filled with the joy of new life that moved in him as well as in the buds and twigs.

And in the Northern lakes a time came when the bass prepared nests for their young. Two by two they swam away

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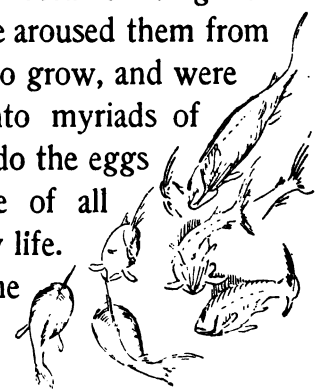
to a quiet place in the clear water; and each pair having selected a smooth spot on the bottom of the pond, they carefully

fanned away all small sticks and other rubbish with their fins, and in their mouths carried away the little stones, until each pair had formed upon the dark bottom of the pond a round

white floor, as clean as though it had been swept. Into these nests the eggs were deposited. As soon as they were laid in the sand by the mother, the other fish poured over them the fertilizing fluid; and when the tiny living particles of this wonderful fluid had touched the eggs, lo! the eggs became living beings. The new presence aroused them from inactivity. They began to grow, and were in time transformed into myriads of little bass. And thus do the eggs and fertilizing principle of all fish join to produce new life. To the young fish come



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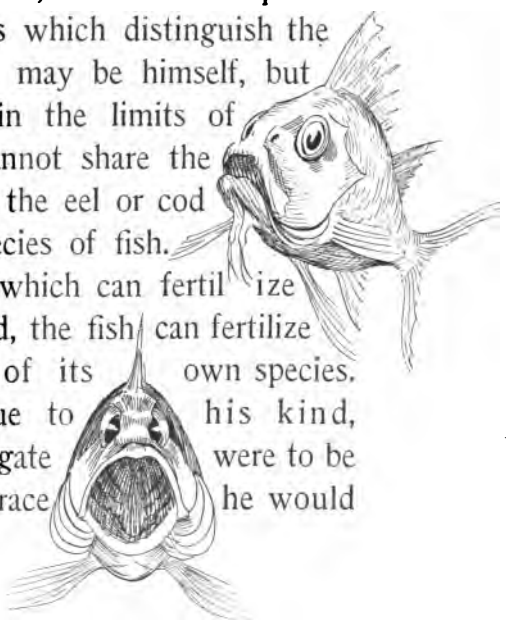
not only the possibilities from its mother's life, but also the possibilities from its father's life. In the tiny egg was contained the whole idea of the mother fish. In the tiny living atom in the fertilizing principle was contained the whole idea of the father fish. The young fish has thus much opportunity for variety, but the power to vary is confined within certain strict limits. The young bass may be unlike any other bass, but he must possess the characteristics which distinguish the bass family. He may be himself, but must keep within the limits of basshood; he cannot share the characteristics of the eel or cod or any other species of fish. Like the pollen, which can fertilize only its own kind, the fish can fertilize only the eggs of its own species. Each fish is true to his kind, and if some profligate were to be untrue to his race he would



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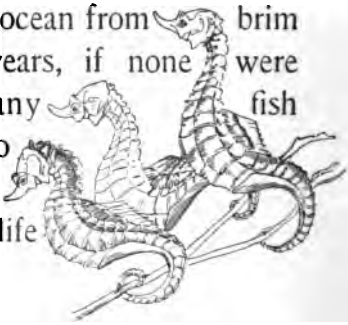
but waste his vital power, for no egg will grow if fertilized by an alien. Eel and bass cannot mingle, nor can cod and pike. He who stocks his pond with trout is quite sure as to what the result will be.

Having laid and fertilized the eggs, the parent bass do not, as many fish do, desert their offspring. They swim about the nest, or hover over it, until the young are hatched and grown large enough to care for themselves. It is an edifying sight to see the parent fish surrounded by a black cloud of tiny creatures to whom he teaches the art of getting a living.

Fish are as prolific as flowers. Sometimes millions of eggs come from one ovary. One pair of shad and their offspring could fill the Atlantic ocean from brim to brim in a few years, if none were destroyed. But many fish are cannibals, and into their ever-ready stomachs the superfluous life



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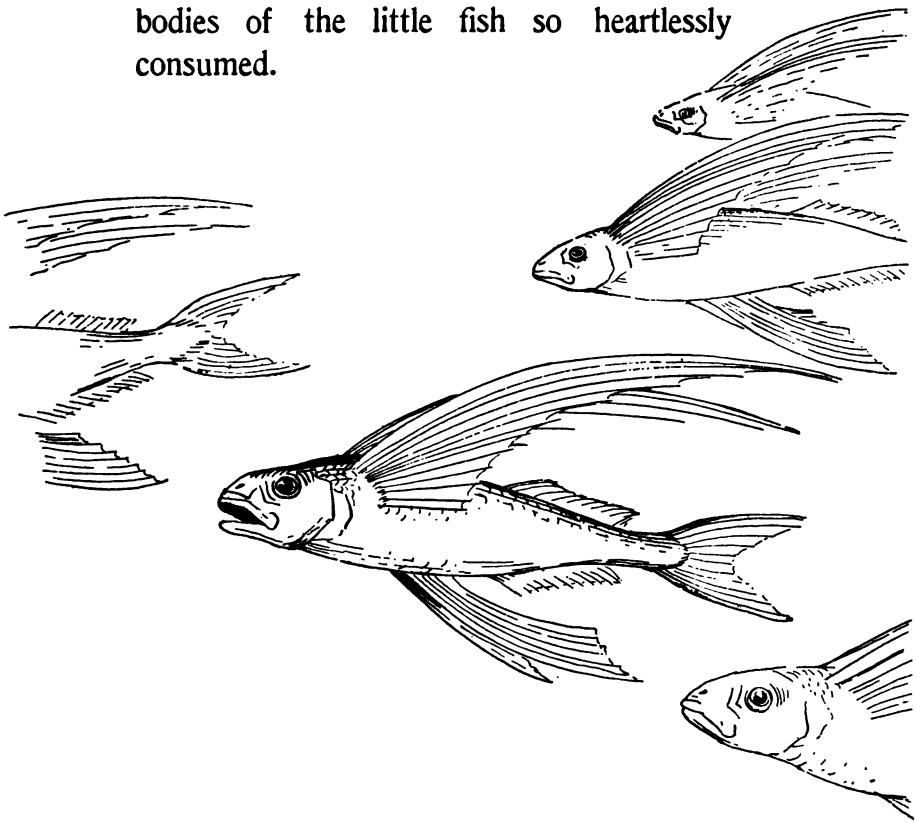
is received, and many little fish are thus converted into material for one big fish.

One cannot help wondering what would happen if the big fish thus nourished were to assimilate the feelings as well as the bodies of the little fish so heartlessly consumed.



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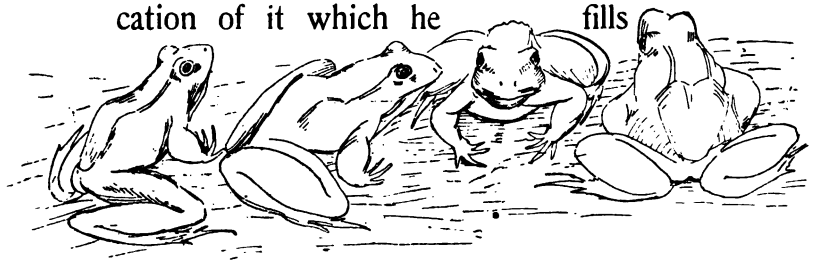
FROGS.

SOMEWHAT higher than the fish in the scale of life is the frog. Although he begins life as a fish, and in the tadpole state breathes by gills, he soon discards the water-diluted air of the pond, and with perfect lungs boldly inhales the pure air of the upper world. His life as a tadpole, although so fish-like, is much inferior to true fish life; for though the fish has not the perfect lung, he has a modification of it which he fills



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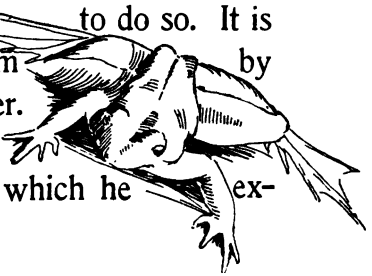
with air, not for breathing purposes, but as an air-sac to make him float like a bubble in the water. Will he rise to the surface? he inflates the air-bladder. Will he sink to the bottom? he compresses the air-bladder. But in the frog the air-bladder changes into the lungs, and is never the delicate balloon which floats the fish in aqueous space. When the frog's lungs are perfected, his gills close and he forever abandons fish-life, though being a cold-blooded creature he needs comparatively little air, and delights to return to his childhood's home in the bottom of the pond. But although he can stay under water for a long time, he is obliged to hold his breath while there, and when he would breathe must come to the surface to do so. It is possible to drown him by holding him under water.



As a feeder the frog relies upon animal life, which he ex-

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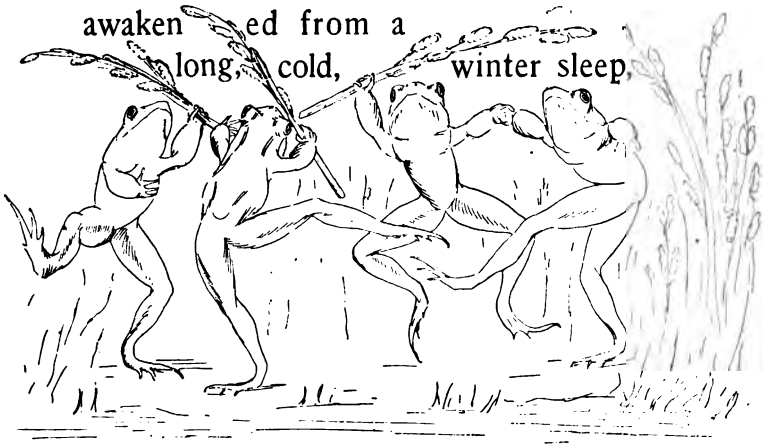
pertly seizes with a tongue fastened by the wrong end, as compared with our tongues. He is a certain marksman, and when he aims at an insect the chances are that the insect will enter his stomach and be there speedily changed into a new form of animal life.

Although from the moment the gills disappear the frog is a true land animal, he is obliged, on account of the fish-like character of his young, to lay his eggs in the water. For this purpose the frogs enter the pools in early spring. The surface of every country pond swarms with the bright-eyed little creatures. They have awakened from a long, cold, winter sleep,



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to find the spring about them and within them. Life has suddenly become abundant and joyous. Their sluggish blood flows faster, their hearts beat quicker; they leap, they swim, they swell out their throats and call to each other in various keys. The toads are with them, and the pretty tree-frogs that change their color to suit their emotions. And all are rapturously screaming. Their voices are not musical, according to man's standard, but seem to afford great satisfaction to the performers in the shrill orchestra of the swamps, who thus give vent to the flood of life that sweeps through them after the still, icy winter.

As though the new spring-life were too plentiful to find room in the frogs and toads already existing, it calls for more frogs and toads; and new creatures are born to share the extra vitality. Like the flowers and the fish, the frogs, too, give forth new life. Within them, too, the

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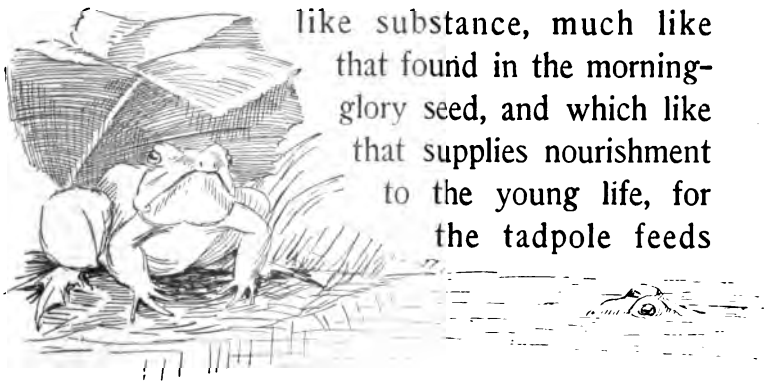
miracle is performed. The tiny eggs of the one wake up and begin to grow. The tiny living bodies in the fertilizing principle of the other also wake up and begin to grow. But higher life is better guarded, because less prolific. The frog and the toad lay but few eggs as compared with the fish. Fish eggs may drop under the stones or float away, and so escape the vital touch of the fertilizing principle. There are so many that numbers may be lost and yet enough remain to continue the family. Not so with the frog family. No egg may be lost. So we find that the eggs of the frog are not dropped singly, like so many shot, but are bound together by a colorless, transparent, jelly-like substance, much like that found in the morning-glory seed, and which like that supplies nourishment to the young life, for the tadpole feeds



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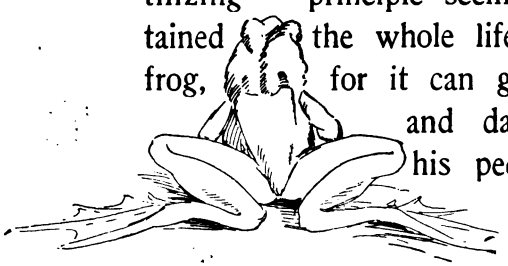
upon it until he is able to seek other food. Moreover, instinct has taught the frog the need of extreme caution in the act of fertilization. Every egg *must* be fertilized. As the time draws near for the dropping of the few eggs into the water, the male frog so places himself that the moment the eggs are being laid, he pours over them, one by one, as they fall into the water, the fertilizing fluid.

And thus the mystery of life is again repeated. The union of the living, microscopic bodies of the fertilizing principle with the new-laid egg is followed by the growth of the two elements into a living creature, able to eat, to breathe, to see, to feel. In some unknown way the atom of fertilizing principle seems to have contained the whole life of the father-frog, for it can give to his sons and daughters any of his peculiarities, either



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of color, form, motion, or disposition; and the tiny egg seems to have contained the whole life of the mother-frog, and can give to her sons and daughters any of her peculiarities; though, as is true of all inheritance, the tadpoles, as the young frogs are called, share the natures of both parents, inheriting some peculiarities from the father and others from the mother.

But, like other life, although the frogs may vary a good deal within frog limits, none of them can escape their own limits and enter into those of any other life. Once a frog, always a frog; and no frog-egg may hope to develop into a turtle, or a bird, or anything but a frog. The life in the fertilizing principle of the frog is sacred to frog eggs, and is lifeless in contact with any other.

Our common frogs, like many of the fishes, do not trouble themselves about the fate of their eggs after they are carefully laid in a safe place. They trust

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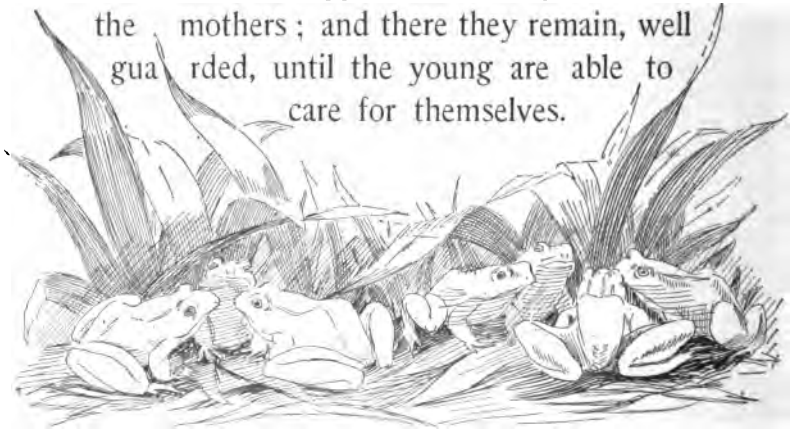
Mother Nature to see the little tadpoles safely through the perils of childhood, to help them change their dresses and get rid of their tails, and cut, not their teeth, but their arms and legs.

In Venezuela, however, there dwells a frog with well developed maternal instinct. The mothers have pockets on their backs, not for their own convenience, but as cradles for their babies. The fathers put the fertilized eggs into the pockets of the mothers; and there they remain, well guarded, until the young are able to care for themselves.



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BIRDS.

TO talk intelligently of birds, one needs to be a bird or an angel. One who moves always upon the surface of the earth, unable to hang suspended above it for even an inch of space, cannot conceive of what it is to be a bird with wings. All animals, and plants too, live on air; but their relation to it is commonplace, ignoble, compared to the relation between the birds and the air. One is tempted to assert that birds *are* air, they are so full of it. Michelet, the bird's lover, thus speaks of it:—

"But this faculty, this rapid inhalation or expulsion of air, . . . whence does it proceed? From an

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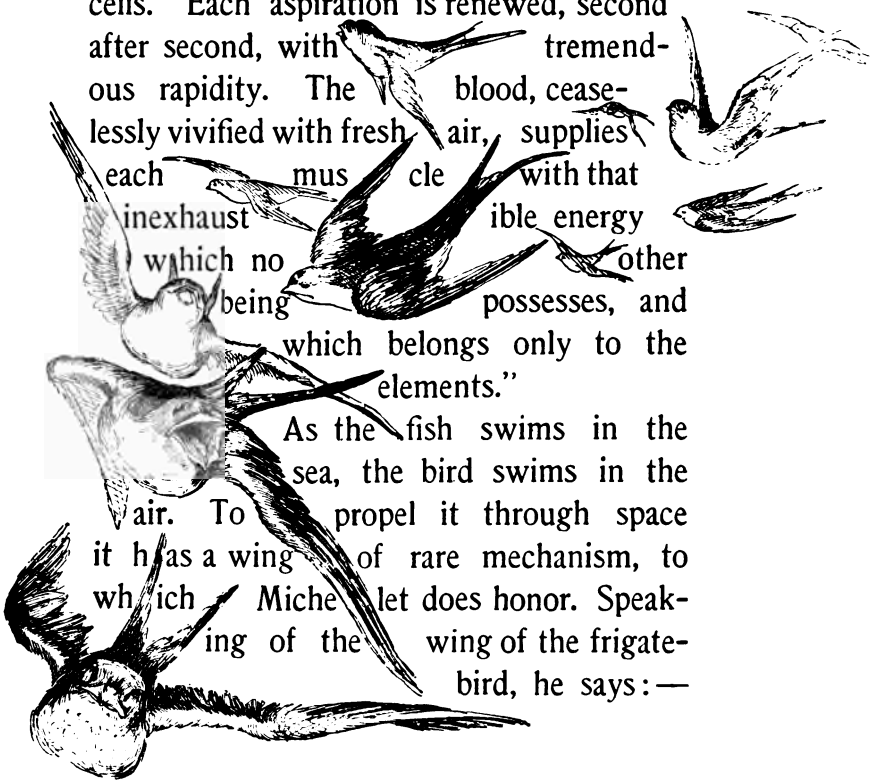
unique, unheard-of power of respiration. The man who should inhale a similar quantity of air at one breath would be suffocated. The bird's elastic and powerful lung quaffs it, grows full of it, grows intoxicated with vigor and delight, and pours it abundantly into its aerial cells. Each aspiration is renewed, second after second, with tremendous rapidity. The blood, ceaselessly vivified with fresh air, supplies each muscle with that inexhaustible energy which no other being possesses, and which belongs only to the elements."



As the fish swims in the sea, the bird swims in the air. To propel it through space it has a wing of rare mechanism, to which Michelet does honor. Speaking of the wing of the frigate-bird, he says:—

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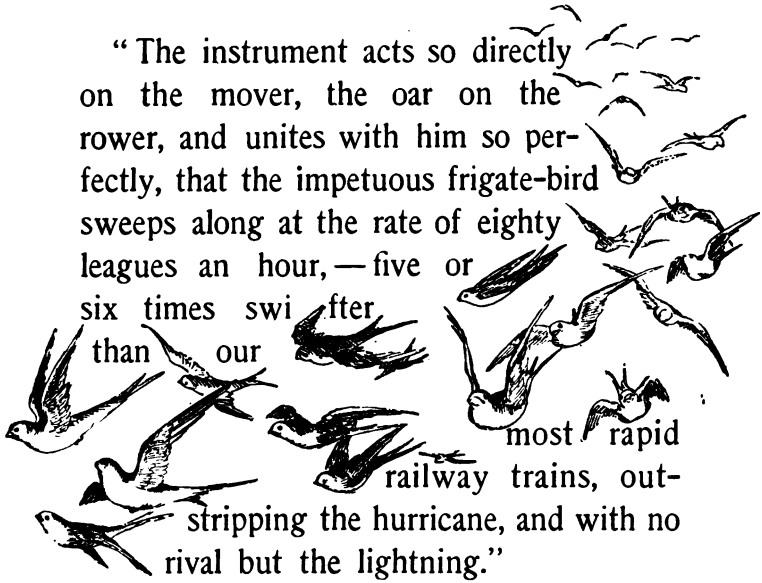

"The instrument acts so directly on the mover, the oar on the rower, and unites with him so perfectly, that the impetuous frigate-bird sweeps along at the rate of eighty leagues an hour, — five or six times swifter than our most rapid railway trains, outstripping the hurricane, and with no rival but the lightning."

And every one knows of the equally marvellous vibrations of the humming-bird's wings, though few understand the tremendous muscular power such vibration expresses. The bird is concentrated vitality. In no other creature is life so like a flame. He seeks in his food fuel to feed the flame, and we find him eating *seeds,* the part of the plant where most nutrition, most vitality is stored; or he takes fruits, the

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best product of the plant next to the seed; or he regales himself upon insects, which, next to himself, contain the fiercest heat of life. He will not feed upon the grass-blades, or coarser fibres of vegetable life; he takes the heart, the life of the plant, for his food.

Where destined to consume decaying animal matter, the bird has a power of digestion as wonderful as is his power of flight; and there is seemingly no limit to the amount of foul nutrition the vulture can convert, in the intense laboratories of crop and gizzard, into the strong fibre of his body.

The bird is so full of life that ceaseless activity is the consequence, and the overplus vitality impels him to violent contests with his fellow birds. The sparrow, oblivious to everything but the rage that animates him, will sometimes allow himself to be caught rather than let go his hold on his hated rival. The

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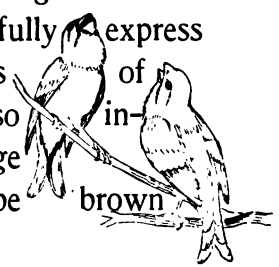
little king-bird will boldly attack and persistently worry the eagle or owl. A lion is not as fierce as a humming-bird, nor as ready to fight against odds.

And there is with the birds, as with all other life, a time of intensest vitality, — a time when life, from its very fulness, creates new life to succeed its decline. As spring colors the earth, the birds sing aloud; their gladness bursts forth from tree and hedge and fence-top, from swamp and hillock; it rises from the earth, it falls from heaven, it flies on swift bright wings. It is the life which overflows from every bird, for the bird which only croaks or squawks at other times makes music in the spring. The new life-current is so strong that not even the swift wings can fully express it; it bursts forth in tones of transport. The vitality is so intense that the very plumage glows. Even though it be brown



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or black it shines with a new light, and in many birds, for a brief time, flashes forth in gorgeous brilliancy of color. Joyous indeed is the life of the birds in the springtime. Space is their dwelling-place and color their heritage, and how dreary earth would be without them! A world without birds, — meadows without bob-o-links, hedges without thrushes, skies without swallows, door-yards without robins and blue-birds, — their color, motion, music, missing!

But the overflow of life in the springtime has a meaning full of hope for the future. New birds are to be. The exuberant vitality is a dowry for the next generation. The life that is, is about to produce other life; and all the joyous vitality finally centres about that one point. With the beautiful spring awakening there awoke a new life in each bird. In one the tiny egg began to grow,

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in the other the fertilizing principle to develop.

But this strange, sweet life of the bird is different from all else we have considered. It is more like our own. There is red, hot blood; there is a highly complicated mechanism of form; and more than all, a quick intelligence, which places the bird high up in the scale of animal life.

The frog's eggs were more precious than those of the fish, because of the more complex life of the frog and consequent smaller number of eggs; the bird's eggs are far more precious still. The simple flower lays its countless eggs; the simple fish also lays countless eggs; the less simple frog lays fewer eggs; and the bird, less simple yet, lays but few, often at the end of the laying season having but four or five. And the life in the bird's egg, — how complex it is; how marvellous the power

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that converts the formless substance into this complicated, living creature!

How great the planning to produce the perfect bird,—all from an egg and an atom of fertilizing fluid! And when the young bird comes, how helpless it is, unable to do aught but open its mouth for food! The care of it is something prodigious, and begins long before it leaves the mother's body. The fish and frogs drop their eggs into the water, where they are fertilized in the simplest manner. The bird builds a nest and sits upon her eggs, supplying warmth from her body until the young come forth. This sitting upon the egg makes necessary a protection to the delicate contents. Were the bird's eggs jelly-like, as are those of the fish and frog, they would soon be crushed and destroyed; but they come forth provided with a hard, firm shell of lime, porous to let in the air—for even the chick in the egg must have air—but impervious to

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liquids. Thus they would seem to be protected against life itself, against the fertilizing fluid, for that cannot penetrate the shell. But there is a time in the history of the egg when it has no shell. The bird's ovaries are on either side of the body, and are filled with tiny, soft eggs, not so large as a pin's head. These eggs grow one at a time, instead of all together, as in the fish and frog. As an egg grows, it becomes separated from the other eggs in the ovary and slides down a tube leading from the ovary to the outer world; but it has no shell. And now is the time for the fertilizing fluid to do its work. Instinct again provides for the new life, and the male bird deposits the fertilizing fluid where the shelless egg lies ready for it. As the egg proceeds on its journey it becomes coated with a covering of lime, until the hard, firm shell encloses, not the egg substance

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alone, but the vital spark of the fertilizing fluid as well, holding these two wondrous elements bound in its close embrace, until they burst it asunder, and — marvel of marvels — emerge from the formless egg-mass, a bird!

One after the other the eggs grow, are fertilized, receive the shell, and are laid. Then comes the long and trying period of incubation, or hatching. The bird must sit, day after day, upon the changing eggs. Scarcely a moment can they be left, for a chill might prove fatal to the life of the forming birds. To no animal can a long period of enforced rest be so trying as to a bird, with its quick-flowing, hot blood, its impetuously throbbing heart, and its love of activity. Why, then, does it do this? Every mother knows; and Michelet, himself a sort of human bird, judging from his tender knowledge of all that touches bird-life, has told it. He is talking of the egg when he says, —

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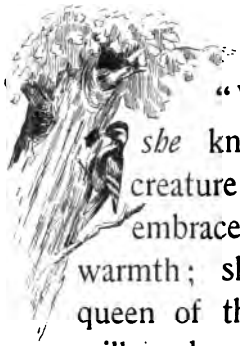

"What is it? I know not; but *she* knows well, — yonder trembling creature who with outstretched wings embraces and matures it with her warmth; she who until now the free queen of the air, lived at her own wild will, and suddenly fettered, sits motionless on that mute object which one would call a stone, and which as yet gives forth no sign of life. . . .

"Yes, that mother knows and sees distinctly by means of the penetration and clairvoyance of love. Through the thick, calcareous shell where your rude hand perceives nothing, she feels by a delicate tact the mysterious being which she nourishes and forms. It is this feeling which sustains her through the ard uous labor of incubation, during her protracted captivity. She sees it, delicate and charming in its soft down of infancy, and she

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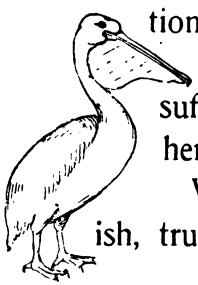
predicts with the vision of hope that it will be vigorous and bold, when with outspread wings, it shall eye the sun and breast the storm.

. . . . . .

"A delightful spectacle, but even more sublime than delightful. Let us be modest here. With us the mother loves that which stirs in her bosom, that which she touches, clasps, enfolds in assured possession; she loves the reality, certain, agitated, and moving, which responds to her own movements. But this one loves the future and the unknown; her heart beats solitarily, and nothing as yet responds to its pulsations. Yet is not her love the less intense; she devotes herself and suffers unto death for her dream and her faith."



What a tribute is this to the unselfish, trusting love of the bird! It would

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seem that its power to love is as great as its marvellous vitality.

All are familiar with the family life of the birds; all know of the tireless devotion and jealous care of both parents during the infancy of the young. All know of the fearless manner in which the parent-bird defends its nest, risking its own life rather than desert its beloved. When danger threatens, its parental love flames forth with a fury that stifles every other emotion. Its own safety is forgotten. It forgets that it is feeble.

"But how help them? It can do nothing but remain at its post and die; it cannot fly away, for its love has broken its wings."

All have watched the demure little mother industriously assisting her busy mate in caring for the family. Bright wings do hard work then.

And in the nest each young bird matures into a being

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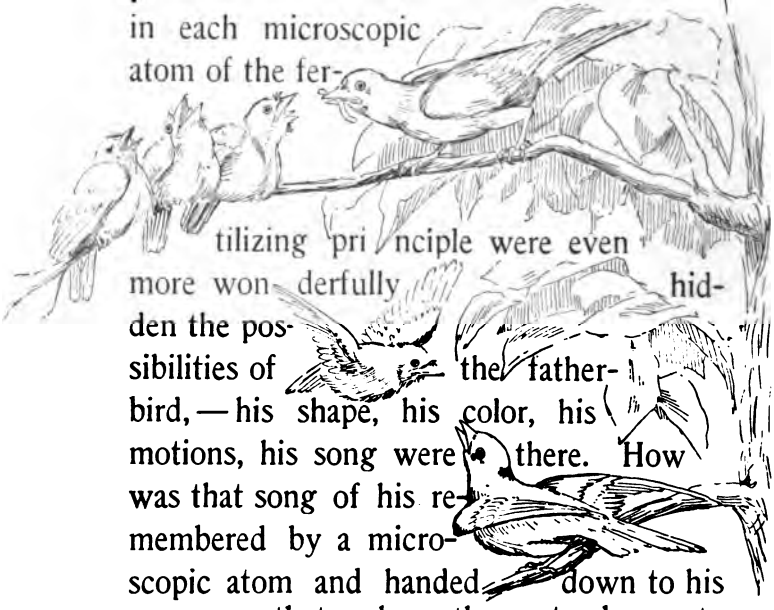
like both parents and like neither. Within each egg was wonderfully concealed all the possibilities of the mother-bird. Within each microscopic atom of the fertilizing principle were even more wonderfully hidden the possibilities of the father-bird, — his shape, his color, his motions, his song were there. How was that song of his remembered by a microscopic atom and handed down to his sons, so that when they stood up to sing, out poured the same melody? Even though the young bird were exiled, so that he never heard his father's song, or the song of other birds of his kind, yet an hour would come when the impulse



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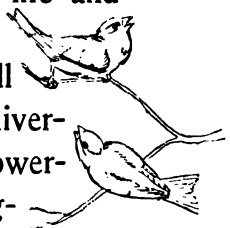
to sing would move him, and forth would burst the old strangely remembered — but never heard — melody.



The law that ruled the flower-life and the fish-life and the frog-life rules also the bird-life, and indeed, all other life there is on earth. A universal law has decreed that the flower-father, the fish-father, the frog-father, — *every* father shall live again in the microscopic particle of fertilizing principle; it has decreed that every mother shall live again in the tiny cell we call the egg; it has decreed that these minute particles shall retain the most perfect stamp of their owners, and be able to transmit any power the owner may possess.

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THE END— AND THE BEGINNING.

PURELY physical vitality reaches its climax in the bird. Such intensity of life and joy we find nowhere else; it throbs in every atom of the hot little body, it performs prodigious feats of flight, it escapes in song so loud and long that no other creature could stand an equal strain. Think of the amount of air set in vibration by a wood-thrush or mocking-bird during its prolonged solo, and then think of the size of the organs that do it. Recall the form of the song-sparrow on the topmost bough of some tree, head thrown back, body quivering, every muscle contracted, while a loud and prolonged melody

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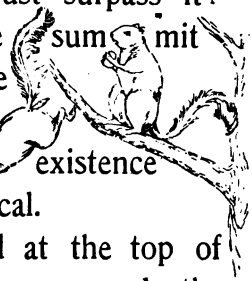
pours from the atom of intense life. No other creature can enter the lists of pure physical life with the bird; there it is without peer.

What is left for the creature who, in the course of development, must surpass it? The bird has reached the summit of physical existence, the next form of life advances farther toward an existence which is more than physical.



Above the bird and at the top of animal life stands the mammal, the wonderful creature that feeds its young with milk manufactured in its own body, as though it could not trust to less carefully prepared or more uncertain supplies to nourish the new life for which it is responsible. In the cow and the goat all are familiar with the milk-giving animals, or mammals, as they are called, and which embrace most of the four-legged and the highest forms of

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the two-legged animals. From the great elephant and fierce lion to the tiny mouse and frisky squirrel we find them. In its power of breathing, the mammal falls short of the bird; its blood is not so hot, and does not flow so fast; its food, in the adult state, is less concentrated, more crude than is that of most birds; and yet somewhere in its creation a new note has been struck, a new being has been formed which is as much higher above the bird as the bird is above the sluggish, stupid, cold-blooded reptile. A type has appeared which finds its highest expression in human life, for man himself is the crown of the mammal. To the less intense physical life is united a higher development of the mind-life.

This mind-life dawns low down in the animal kingdom, but not until the higher mammals were reached did it give a hint of the possibilities it contained, and which in man were to reach such marvellous re-

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sults. The bird may stand at the summit of physical life, man stands at the summit of mental life. The vitality which creates a great thought is more wonderful than that which propels the frigate-bird through the air. Man's wings are in his brain; he can outfly the wind,—electricity cannot girt the globe quicker than his thought. The farthest star is not so far but that his mind can wing its way through the illimitable space and alight there.

And from his high position man gets the first dim glimpses of a still higher state. Having reached the summit of earthly possibilities he finds himself at the borderland of another life. Like the plant, which is joined to the lifeless mineral on one side and just touches the warm animal vitality on the other, he is joined to the crude animal life on one side and just touches the dim mystery of the spirit life on the other. He catches brief glimpses of a life of blinding possibilities, which cast over

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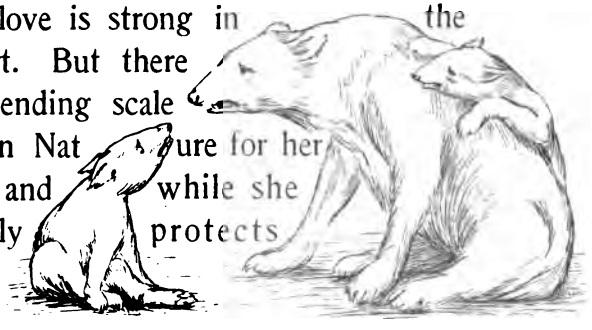
his prosaic, every-day life on earth a helpful glow.

And this wonderful spirit of man is lodged in a body whose complexity surpasses that of all other animals. Although more active, even the bird is less complex; and its wing, wonderful as it is, cannot compare in structure with the hand of man. The human hand alone, with its delicacy of touch and its ingenious structure which enables it to make thousands of different movements, is enough to make its possessor master of the world.

We have observed how, as the creature becomes more complex, its reproduction becomes a matter of greater moment. The young bird-life is jealously guarded, and parental love is strong in the bird heart. But there is an ascending scale of love in Nature for her children; and while she ingeniously protects



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her bird-life, she exhausts device in caring for her noblest offspring, the mammal.

The mammalian mother is united to her child by peculiar and all-powerful bonds. She literally shares her life with it. Hers is the perfect motherhood, and her love for her child pales every other passion. There are among the lower animals parents that desert their young, or deliver them over to the care of strangers. Among birds there are species that lay their eggs in other birds' nests, and take no further thought of them. There is nothing like this in mammalian life. In its whole range there is no mother that deserts her child. The life of mother and child are so intimately connected that neither can exist without the other. The motherhood of mammalian life is the most sacred thing in physical existence. The very food of the young animal is part of its mother's life and is formed within her body. No other food is so sufficient and so concen-

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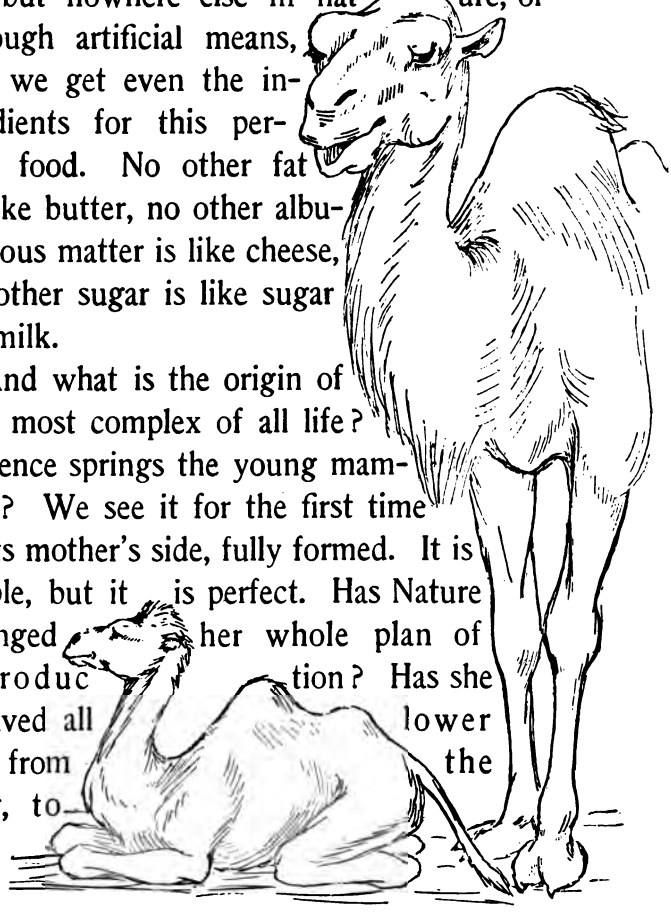
trated. It is manufactured in a laboratory whose secrets have never been discovered. We analyze milk and know what it is made of, but nowhere else in nature, or through artificial means, can we get even the ingredients for this perfect food. No other fat is like butter, no other albuminous matter is like cheese, no other sugar is like sugar of milk.



And what is the origin of this most complex of all life? Whence springs the young mammal? We see it for the first time at its mother's side, fully formed. It is feeble, but it is perfect. Has Nature changed her whole plan of reproduction? Has she evolved all lower life from the egg, to

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cast it away as inadequate to the needs of the mammal? Has she through the egg solved the question of reproduction for plants as well as animals and at last failed because her plan was not perfect enough to go one step further?

To contemplate the subject before us, let us go into the wild wood, far away from the noise of cities. Let us go where all is clean and sweet and fresh in the beauty of early summer. The birds are not there, for they love the more open places; but life is there in shapes as beautiful, for between the distant tree-trunks move dim forms. A magnificent pair of antlers is half hidden by the leaves. A slender doe daintily speeds away with a speckled fawn at her side. Pretty, hornless heads and great soft eyes bear witness to the presence of other members of the same family, but they are so shy we seem to feel rather than see them; and to our half dreaming senses the breeze and flut-

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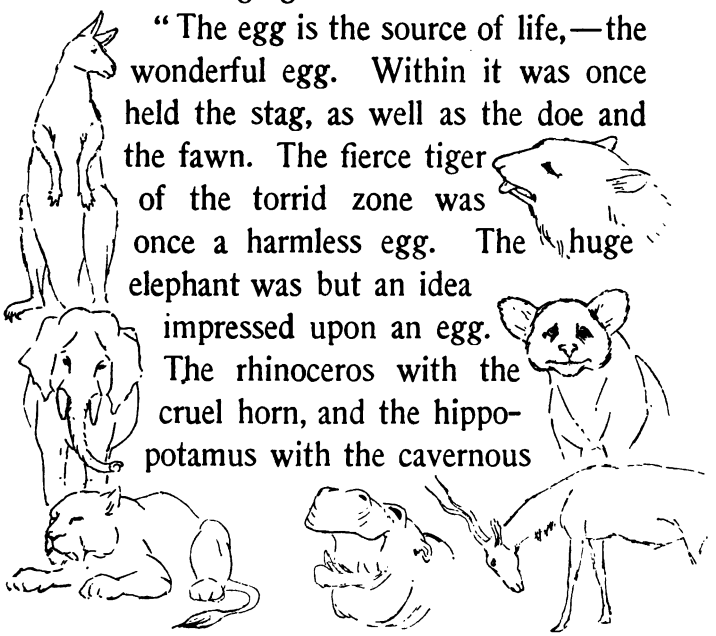
tering leaves take up the song of life. And this is the song they sing: —

"The beautiful doe as well as her fawn, the stag with his antlers, all began life as a tiny, oh very tiny egg."

"O wind and leaves, you must be mistaken!"

But the wind shakes the leaves and laughs aloud, and goes sweeping through the forest singing this refrain: —

"The egg is the source of life, — the wonderful egg. Within it was once held the stag, as well as the doe and the fawn. The fierce tiger of the torrid zone was once a harmless egg. The huge elephant was but an idea impressed upon an egg. The rhinoceros with the cruel horn, and the hippopotamus with the cavernous



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mouth were only eggs. The race-horse began life as an egg. The watch-dog, too, was a very little egg. The black cat now stealing the egg from the hen's nest was herself once an egg a hundred times smaller than that she steals. Oh the egg, the wonderful egg—egg—the egg!"

And the wind dies away, leaving us much food for thought, for all that we have heard is true. The mammalian egg is as much a reality as is that of the fish or the bird. But under ordinary circumstances it is never seen, being exceedingly small and remaining during its period of development a captive within the mother's body. It is therefore not strange that for ages the presence of this hidden mystery escaped detection. All sorts of theories were afloat as to the origin of the young mammalian life, but that it came from an egg, like all other life, was not apparent.

Nevertheless, on either side of the mammalian mother's body, just as in the fish,

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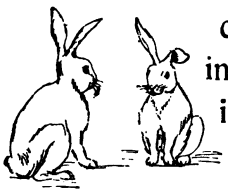
frog, and bird, lie the ovaries. The eggs they contain are so small that to predict a living animal, like a lamb or a calf, or even a rabbit or a mouse, from one of them seems absurd; and yet the whole life of the animal is compressed within the tiny vital spheres. The doe's egg is not so large as the smallest pea. Its possibilities are colossal. Let us consider its development. One egg, or sometimes two, develops at a time. The egg, when mature, leaves its companions in the ovary and finds its way through a tube connected with the ovary into a pouch into which the tube opens. Although no larger than a number eight shot, within this tiny egg is the possibility of becoming a deer. But its life is not abundant enough to effect the transformation alone; other life must be added to it. As in the case of the bird, the fertilizing principle is added to the incomplete life eager to live



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and grow. Two infinitely small atoms of vitality join forces, and the result is the complex creature we call a deer.

Slowly the new life forms; to the original tiny particle of living matter must be added great store of nourishment. In the other eggs considered, food was stored up in the egg and pure air found its way through the porous egg-covering; but here is no provision in the tiny egg for either food or air. This child must owe all to its mother. Every particle of life must proceed directly from her. Her lungs must breathe the oxygen it needs. Her food must furnish it material for growing. Its very blood must flow from her heart; and she is, in every fibre of her loving body, ready to meet the demand. Large blood-vessels seek the room in which the formless captive lies, and carry to it blood, rich and pure. The food which the mother eats serves not only for her own nourishment but also for the growth

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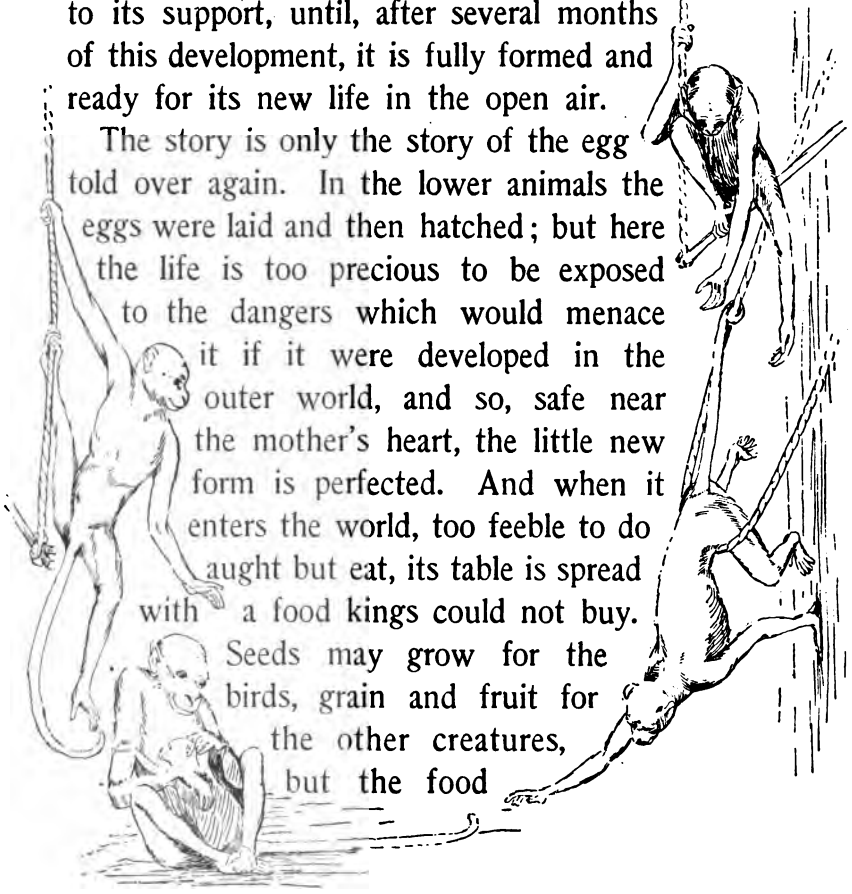
and nourishment of that wonderful being, her other self, that lies under her heart. As the fawn grows larger, more and more of the nourishment the mother takes goes to its support, until, after several months of this development, it is fully formed and ready for its new life in the open air.

The story is only the story of the egg told over again. In the lower animals the eggs were laid and then hatched; but here the life is too precious to be exposed to the dangers which would menace it if it were developed in the outer world, and so, safe near the mother's heart, the little new form is perfected. And when it enters the world, too feeble to do aught but eat, its table is spread with a food kings could not buy. Seeds may grow for the birds, grain and fruit for the other creatures, but the food



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of the little fawn comes only with the sweet mystery of motherhood.

And what is this milk, — this food which gold cannot buy, but which is a free gift from the mother to her child, this delectable drink that springs from the mysterious fountain of life? It is all that the fawn is. It is bones, muscles, blood, tissues, and organs of all descriptions. Complex as the animal is, it contains nothing which did not at first exist in some form in the milk.

The doe-mother is nothing as far as the development of her own life is concerned. She is for the time obliterated, merged in the life of her fawn. The lime she consumes does not go to replenish her own bones, it collects in the milk to develop the bones of the fawn. The albumen she extracts from her food does not nourish her muscles; it is stored away in the milk for the fawn; and the mother loses flesh and beauty because

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giving the best of her life to her child. And all her loyal mother's life she will gladly give if her child requires it. Justly man reverences motherhood.

It is unnecessary to repeat that the manner of reproduction of *all* mammals is the same. Man himself passes through the wonderful transformation. The higher mental powers, already begun in the lower animal, find their fullest development in him; but he starts like the rest, as a formless speck of living matter.

The child is everywhere but a budding of the parent, — a blossoming of existing adult life into the lovely flowers of infancy.

We know the facts of renewed life; the great mystery of it we do not know. The soul within the strange and beautiful body is shrouded from our gaze as completely as it was from the gaze of our forefathers.

We have outstripped them in knowledge

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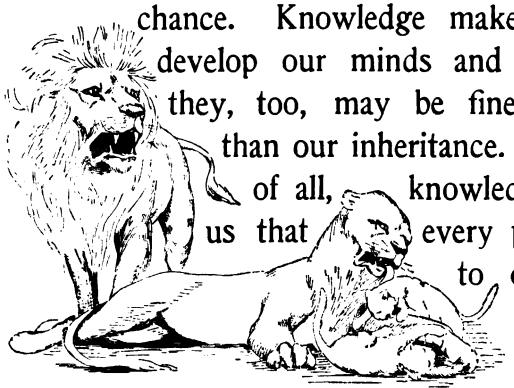
of material facts; in knowledge of spiritual ones we have not advanced one step. This only is certain, — that we go on and on forever. Not only what we have inherited, but what we have gained by our own efforts, sets its stamp upon our vital forces, and vibrates through the future ages. We, more than all the rest of the animal creation, have knowledge. This knowledge informs us that our bodies are temples, sacred receptacles of a soul, and are the altar-flames for future beings. Knowledge enables us to care for our bodies so that they may become stronger, more beautiful, and more perfect than our inherited bodies could have been if left to chance. Knowledge makes us able to develop our minds and souls so that they, too, may be finer and higher than our inheritance. And grandest of all, knowledge has taught us that every power we add to our own lives



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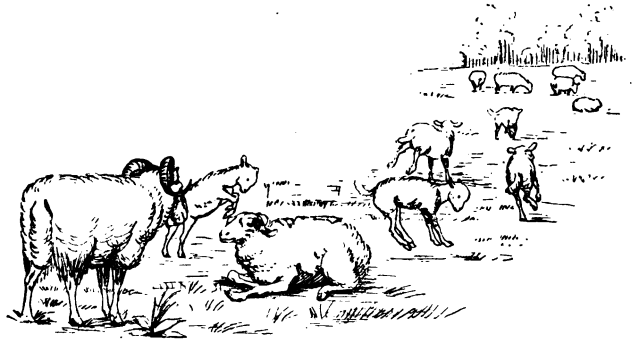
may be handed down, a richer inheritance than gold, to our sons and daughters.

We know that the efforts we make are tendencies stored up like the bird's song, and that in some mysterious way these tendencies may wake up in our beloved child and through his efforts grow yet stronger. We know that each new generation may reach greater perfection than the one before it, and we know that the lives which we of to-day live are the stamps that impress the possibilities upon the life of the future. Were man's desire in proportion to his knowledge, he could soon people the earth with inhabitants of perfect beauty and nobility.



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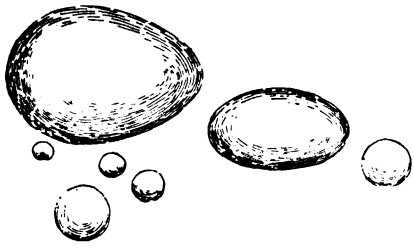
THE WORLD'S CRADLE.

"EVERYTHING SPRINGS FROM THE EGG;
IT IS THE WORLD'S CRADLE."



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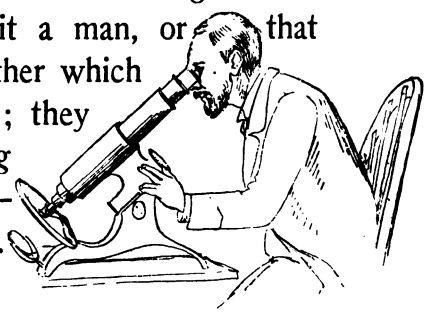
THE WORLD'S CRADLE.

WITHIN the egg may lie dormant the future statesman or next summer's butterfly. So far as the appearance of the egg-substance is concerned there is no more reason to expect the one from it than the other. The butterfly's cradle, to human ken, contains neither less nor more than the man's. The finest chemical test cannot point out that something in the one which makes it a man, or that something in the other which makes it a butterfly; they are to all seeming similar bits of semi-fluid, animal matter.



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The best he who is curious about the life within the egg can do to understand the miracle is to watch the changes that occur as the egg advances from a structureless fluid to an organized being, to watch it proceed from so simple a thing as an egg appears to be into so complicated a thing as a frog or a robin or a Sir Isaac Newton. Human eyes cannot, under ordinary circumstances, see these changes; the wonderful eye of the microscope must first be fixed upon them. Observation has, however, told every one a few facts about the hen's egg which are helpful in understanding the development of all eggs. We know that the hen's egg consists of a yelk surrounded by the soft, jelly-like "white;" and if we have looked carefully enough we know that the yelk is held in place by a delicate wall, which surrounds it and separates it from the "white." When we examine other eggs we find that all have a part correspond-

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ing to the yelk, surrounded by a wall, and generally a part corresponding to the "white." In the yelk of the egg lies the vital something which is to awaken into conscious life. The "white" is merely food stored up to nourish the young creature while it is being formed. The yelk is a mixture of oil and other materials, among which is a clear, jelly-like substance which resembles the "white" of egg, and is called protoplasm.

What could appear less interesting than this semi-fluid, slimy protoplasm? Yet approach it reverently, for it is the one great, inscrutable mystery of the physical world. The Alps tower snow-clad above the plains below, and man gazes at them with awe. The stars shine out as they follow through fixed courses night after night, and year after year; and the immensity and mystery they express fills the earth-bound gazer with more than awe. And when he turns to the insignificant

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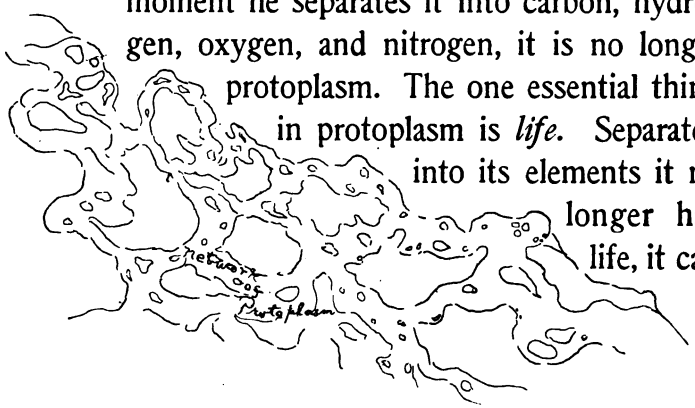
atom of protoplasm at his feet, and his mind suddenly opens to its meaning, behold! it is greater than the Alps, more marvellous than the stars, for in it is contained the mystery called life. Protoplasm is the only living substance. Every plant and every animal which now lives, or has ever lived, began life as a bit of protoplasm. It is the protoplasm which builds the animal or vegetable form. It is the protoplasm which is the living part of every creature.

And what is this protoplasm? The chemist has dared to analyze it. He tells us it is composed of carbon, hydrogen, oxygen, and nitrogen. A delusion! The moment he separates it into carbon, hydrogen, oxygen, and nitrogen, it is no longer protoplasm. The one essential thing in protoplasm is *life.* Separated into its elements it no longer has life, it can



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no longer change into a tadpole or a bird, or any living being. This dead thing the chemist analyzes has no more interest for us than so much charcoal. The chemist failed to seize upon *life*. As soon as he began his analysis that escaped. All his wonderful appliances were not wonderful enough to find it; and to-day we are as ignorant of the true nature of protoplasm as though chemistry and biology and philosophy, and all the other sciences, had never existed. We only know that it is a mysterious living substance upon which every living thing depends; that unmixed with other substances it is clear and jelly-like, while mixed with oil and other materials it forms the most important part of the egg-yelk, the part destined to become the animal.

When protoplasm, existing alone or mixed with other substances, is surrounded by a wall like the wall of the egg-yelk, we call the little bag of protoplasm

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a cell. A cell may also exist as a bit of protoplasm without a wall, and may be of almost any shape. A cell is usually found in combination with other cells, though it may exist alone. In fact, there is a complete animal which is no more nor less than a naked cell of protoplasm. Its name is *moneron*. It has no nerves, no heart, no lungs, not even a cell-wall. And yet it is a living thing, and something in it makes it want to move. It has no legs to go on, but its body is most convenient, being a speck of protoplasm, all parts of which are alike endowed with the power to serve every purpose. Thus, when it would move, it protrudes a finger-like bit of its body, like a feeler; the rest of the body gradually flows along until it has caught up to the advanced part, or if the creature is minded to go yet farther, another finger-like part is

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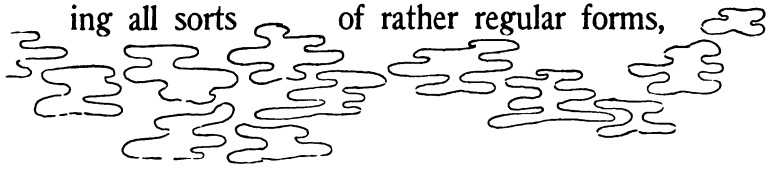
advanced like the first to tempt the main part on. Being an animal, the moneron must eat. This it does by enfolding its body substance about the bit of matter it is to consume. This body, though it seems but a speck of jelly, attracts all of the nutritious matter from the speck it has encased, and this done, flows away and leaves the rest.

The moneron would have a child. It contracts through the middle, and continues to contract until there is no middle left. The moneron has thus divided into two parts, — made two monera of itself, though which is parent and which is child is an unanswerable question. In the picture we see the upper moneron putting out a finger-like process to the left. Just below it is a moneron dividing into two monera. Next below we see the division complete, and after that the monera assuming all sorts of rather regular forms,



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somewhat more regular than usual, as they are desirous of forming a pleasing decoration of themselves.

Although the moneron is an example of a single cell conducting itself as an independent animal, the cell is usually only one infinitesimal part of the whole animal or plant. It is generally supplied with a wall, and is usually very small,—often so small that, like the moneron, it can be seen only with a microscope. The yelk of the hen's egg is therefore a very large cell. The tiny living bodies in the pollen and in the fertilizing fluid are small cells, and their shapes are often wonderful. In fact the cell assumes a special form for each kind of tissue, and under the microscope may be recognized as the irregular nerve cell, the spherical fat cell, the hexagonal pigment cell, or whatever it may be; and with the connecting tissues in which it embeds itself forms very wonderful and beautiful combinations, in both

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form and color. Believing that the interest felt by many young people in the beauties revealed by the microscope is greater than their knowledge of microscopic facts, the animal cells have planned to place themselves in an attractive form before the readers of these pages. They accordingly present themselves in their microscopic shapes, accommodatingly lending themselves to the purposes of decoration by forming groups in pretty conventional designs.

We remember that the yelk of the egg is composed of protoplasm, oil, and other materials. The protoplasm may be mixed uniformly through the yelk; or, as is the case in the eggs of some animals, the protoplasm may be collected in one part of the yelk, the rest of the yelk being composed of the oils and other materials. As soon as an egg has been fertilized its protoplasm suddenly wakens to the fact that it is alive and has work to do. It is

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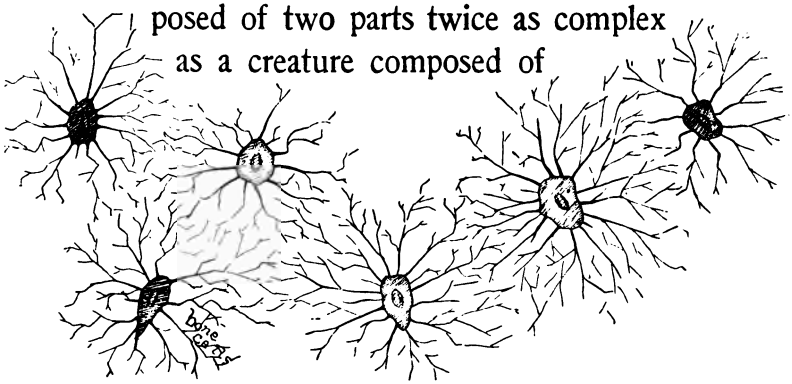
stirred with a desire to become a trout, or a frog, or a robin, or whatever creature its parent may be. But what can it do? It is but a simple jelly-like speck, — a living speck, however, and one bent upon becoming more complex; so it performs a simple act, as befitting so simple a creature, — it imitates the moneron and divides into two parts. Its division, however, does not make of it two creatures equally simple; it remains one creature still, but a less simple one. It has taken the first step in the life-changes that convert an egg into an animal.

This division into two parts is the triumphant departure from formless matter to complex life. Is not a creature composed of two parts twice as complex as a creature composed of



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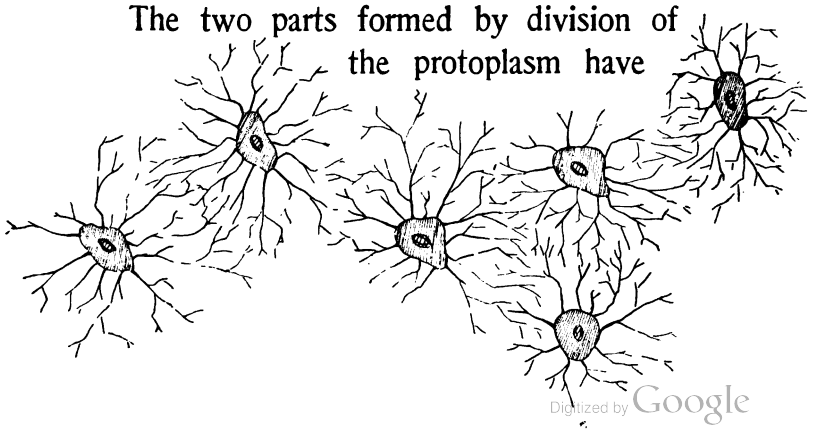
one? it seems to ask. Where the protoplasm is mixed uniformly through the yelk, at the moment of division the whole yelk divides into two parts. The protoplasm has heard a voice it must obey; the fat and other matters are so thoroughly mixed with it that it cannot separate itself from them, so at its moment of division it carries all with it, and thus the whole yelk divides into two yelks. Where, however, the protoplasm is collected by itself in one part of the yelk, the protoplasm divides into two parts, leaving a portion of the yelk still unchanged. This unchanged portion afterward serves for food, and is absorbed into the body of the animal as it grows.

The two parts formed by division of the protoplasm have



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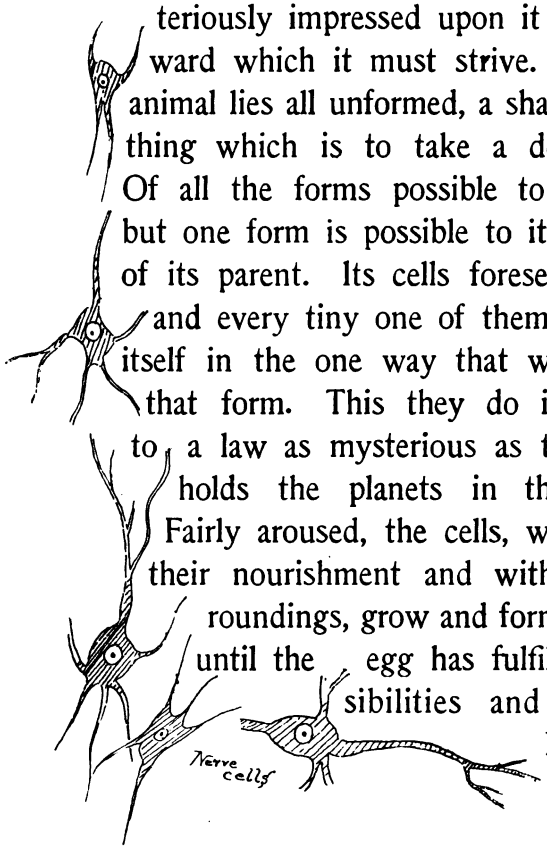
rounded corners. They have become two perfect cells. And in these active cells we have all that is necessary to make the most complicated animal in the world — for man himself is made of cells of protoplasm. Each cell has mysteriously impressed upon it an ideal toward which it must strive. The future animal lies all unformed, a shapeless something which is to take a definite form. Of all the forms possible to animal life, but one form is possible to it, — the form of its parent. Its cells foresee this form, and every tiny one of them disposes of itself in the one way that will result in that form. This they do in obedience to a law as mysterious as the law that holds the planets in their courses. Fairly aroused, the cells, with food for their nourishment and with right surroundings, grow and form other cells, until the egg has fulfilled its possibilities and become a living being.



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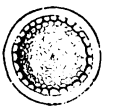
At the beginning the cell seems to do nothing but divide, for we are hardly sure the protoplasm has divided into two parts before we discover it has divided into four. Each of these four cells divides; the new cells so produced divide; and so on until the original yelk mass has lost its smooth, oily nature and become a much firmer mass of tiny cells. These little cells which we have seen formed crowd close together, and finally flatten out against the yelk wall, where they adhere to each other by their edges and form its inside lining. This lining, which we must not forget was once the yelk and is now a layer of cells, is called the *blastodermic membrane;* and we can forgive its long name when we learn that it is now the body of the *embryo,* as the animal in these early stages is called.



It is no longer a formless mass, but a true living animal. Its cells have not, moneron-like, divided into a number of

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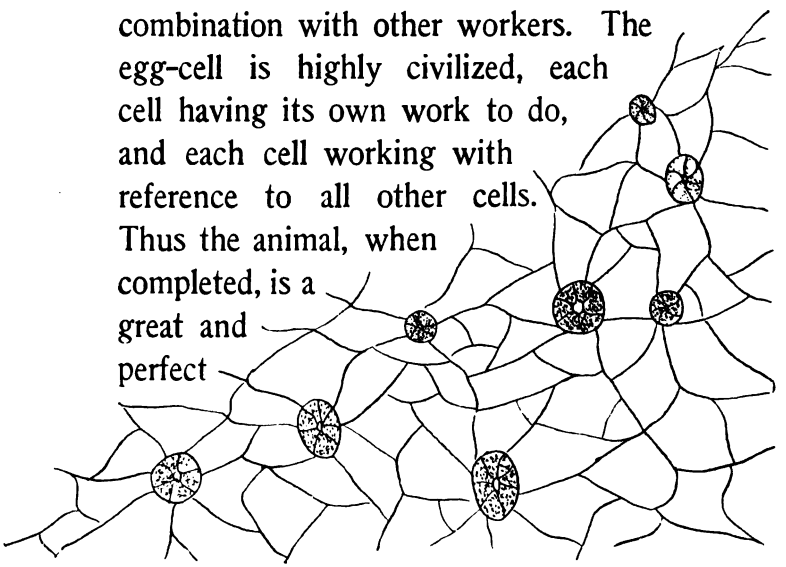
separate creatures, they have formed a little community in which each cell has its own special work to do. The moneron cell is a savage, — it must do everything for itself. It must, as it were, be its own cook, shoemaker, tailor, hunter, and all else. Consequently its life is very simple; for the savage, being obliged to do everything for himself, cannot have so much as the civilized man who does one thing well and quickly and exchanges it for some other person's work, or who acts in combination with other workers. The egg-cell is highly civilized, each cell having its own work to do, and each cell working with reference to all other cells. Thus the animal, when completed, is a great and perfect



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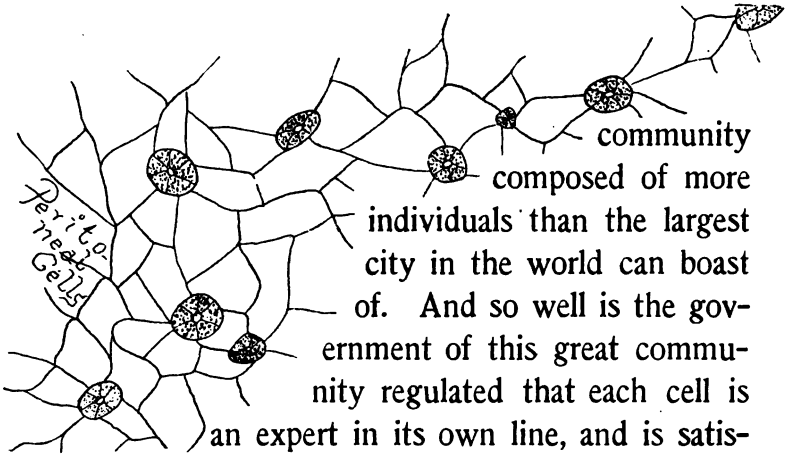

community composed of more individuals than the largest city in the world can boast of. And so well is the government of this great community regulated that each cell is an expert in its own line, and is satisfied with its station in life. The skin cells are satisfied to make good skin, the bone cells to make good bone; and no one ever heard of the cells going on a strike, unless that is what they do when the body is abused and the cells rebel, and then we call it disease.

But in the embryo stage, while the cells rule, and before the completed animal tries to rule — or overrule — their good action, the cells all do happily and well their own work. Although the cells that flatten themselves against the yelk-wall are the

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earliest form of the young animal, it is in that state so immature that we no more recognize in it an animal of any kind than we recognize a frog in a tadpole, unless we have watched a tadpole change into a frog, as we are now about to watch the blastodermic membrane change into an animal.

What is it to become? a fish? a frog? a child? That we do not know; for up to the present stage of transformation fish, frog, child, or any other high form of animal life must travel the same road. In all alike the protoplasm must change to cells and the cells must form the blastodermic membrane. Although up to a certain period the first simple changes in the eggs of all animals are so alike that it seems as though the egg might as easily become one thing as another, yet the seal of the parent is somewhere set upon the budding life and impels it to assume the one form. Michelet, speaking of the de-

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velopment of the young bird, has beautifully expressed the parental prompting which moulds the form in the egg of every creature: —

"But see how, in this divine sleep, it has recognized its mother and her magnetic warmth. And it, too, begins to dream. Its dream is of motion; it imitates, it conforms to its mother; its first act, the act of an obscure love, is to resemble her."

Though the creature is now but a layer of cells, yet in that simple form is somewhere hidden the "obscure love" which prompts it to grow to the likeness of its parent. And after a time the being hidden in the blastodermic membrane of each egg asserts itself. It is no longer content to remain in a state common to all animals. It begins to express its obedience to the law of heredity; it is about to resemble its parents. And since the blastodermic membrane is about to disclose

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itself, to show what definite creature it has been meditating during these early obscure changes, — whether a tadpole, a robin, a rabbit, — it will be well for us to fix our whole attention upon the blastodermic membrane of one egg, and watch it reveal its secret. We select an egg in which this membrane has just formed. As we watch it, it divides into two layers, thus providing the yelk-wall with a double lining, the outer and inner layers of the blastodermic membrane, and supplying itself with two corps of workers, each corps fitted to a special kind of work.* Each layer is formed of cells. The cells that make the outer layer (*a*) are small and close together, and build up the

* As a matter of fact the blastodermic membrane has formed still another layer between the outer and inner layers. This middle layer has again divided into two layers. But as the middle layers are formed from the outer and inner layers and share their work with them, we will not give the inner layers any attention, — for simplicity's sake speaking only of the outer and inner layers.

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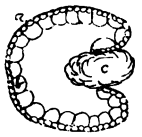
denser parts of the animal, such as skin, bone, muscle. Those that make the inner layer (*b*) are larger and looser, and build up the less dense parts of the animal, such as the intestines; *c* in the diagram is the unchanged yelk, which is to form food for the embryo.



The cells build and we watch. But what a disappointment is here! Our embryo is only that of a worm! We are well acquainted with the development of a certain primitive form of sea-worm, and here it is. We are about to turn away from the microscope through which we have been gazing, when we notice that one point in the outer layer of the blastodermic membrane, that which forms the outer covering to our forming worm, begins to thicken. We see the cells at that point dividing very fast and crowding close together about a certain oval space, until two ridges are formed which rise up on each side of the space and meet over-

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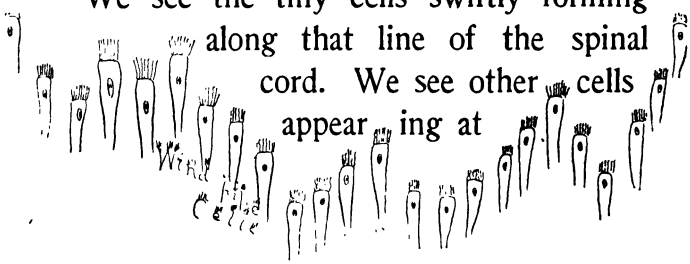
head, forming a hollow canal. And now we know that the cells have not designed a worm, for a worm has no brain, and this hollow canal is the first step toward what will one day be a spinal cord and brain.

The cells would have stopped building, and finished the creature into a worm, had it not been for that parent form which urged them to itself, and toward which they loyally pushed. And so, blind to every other form of life, the cells work on,—those already formed grow and divide into other cells, and these in turn grow and divide, and so on and on. Each kind of cell has, as we know, its own shape. Each unerringly fits into its own place and does its own work.

We see the tiny cells swiftly forming along that line of the spinal cord. We see other cells appearing at



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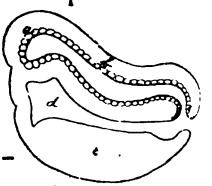
different places, cell joining cell, forming mysterious little points and projections. O cells, who tells you what to do? In your dark little house how do you know, each one of you, just the one form, out of numberless possible forms, which *you* are to take? How do you know just the one spot which *you* are to occupy in that confused something which is forming there? O cells, tell us of the Power back of you, which we value more than all your work!

But the cells silently, swiftly take their places, forming a more and more complicated-looking object, which we here see as it was once seen by a great man, after he had spent many hours working with the microscope, for the object we are watching is so small that it is invisible without the aid of the microscope. It seems meaningless at a first glance; at *a*, *b*, *c*, are the cells which have grouped themselves to



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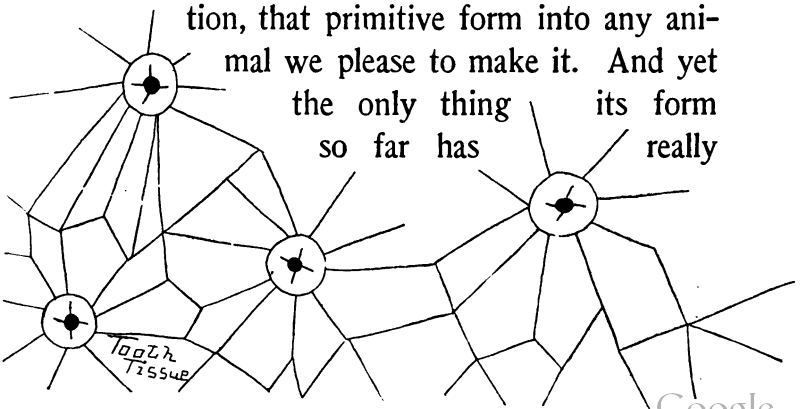
form the beginning of the spinal cord. We see there a tube, the walls of which are formed by cells which will one day grow into the brain and spinal cord. Curving around at *a* is what will be the head, with the upper end of the spinal cord enlarged into the brain. The space below, *d*, is where the digestive canal will finally be formed, and in *e*, below that, we can readily distinguish the enlarged abdomen. In fact, it requires but little imagination to transform the part at *a* into the head, to see legs budding at the opposite ends of *e*, or wings from one end and legs from the other, or fins from both ends instead of legs or wings.

We can easily transform, in imagination, that primitive form into any animal we please to make it. And yet the only thing its form so far has really



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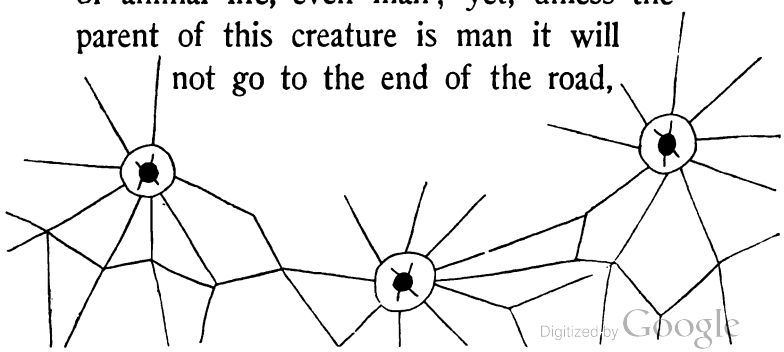
told us is that it is to have a spinal canal and brain. We are sure, therefore, that it will not be a clam or a fly or a worm; and were it not for its size — which tells part of the secret, for our egg is too large to belong to a mammal — we would not know to which class of back-boned animals it belongs, and might well hesitate to give an opinion as to whether it is destined to become a lizard or a kitten. Meanwhile the cells, relentless as fate, are building the future animal. The creature they are forming passes through many stages similar to those passed through by the embryos of other animals, yet is its destination as certain as though no other creature ever travelled that road. The road of development ends in the highest form of animal life, even man; yet, unless the parent of this creature is man it will not go to the end of the road,



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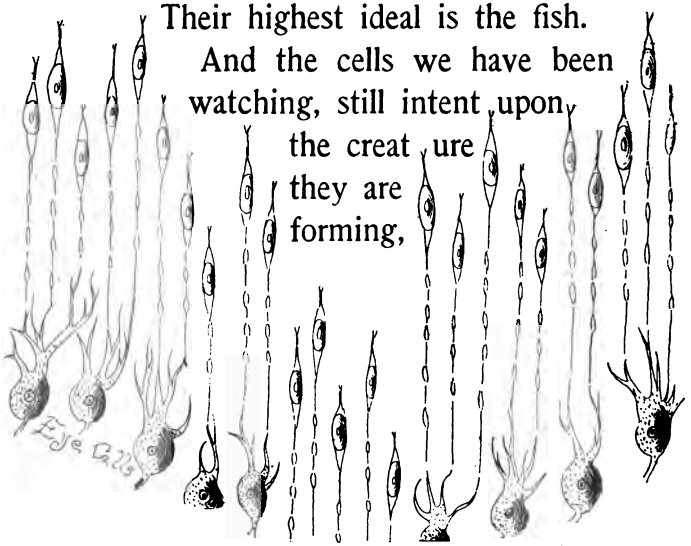
but will finally reach a side path leading to its own parent form, and down this path it must turn. To pass the entrance to that pathway and go even one step beyond is as impossible for it as it would be for the sun to change its course. If it will not enter that path it must die. Its life is to be found there and there only.

The cells are as loyal to their caste as were the ancient Hindus. The cells of the fish do not aspire to form a bird, their only desire is to make a perfect fish. Their highest ideal is the fish.



And the cells we have been watching, still intent upon the creature they are forming,

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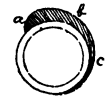
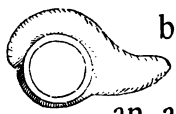
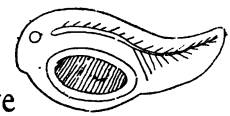
busily grow and divide, grouping themselves about and below the embryo, until they have formed a body-wall quite around it. Here is a side view, — *a*, *b*, *c* representing the back of the embryo.



That which we now see is the work done by the cells in the outer layer of the blastodermic membrane. These cells continue to group themselves, forming muscles and skin and bone; and now behold our mysterious animal with a tail! Cell after cell builds itself into the forming body until we are at last sure that an animal which we can recognize is coming. Here he is beyond a doubt, — the most interesting baby frog, or tadpole, as he prefers to be called, that our eyes ever beheld; for have we not seen him grow up, cell by cell, from the very foundation?





But what have the cells of the inner layer of the blastodermic membrane been doing all this time? Have they forgotten

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their work? If we recall the way our animal was last represented we find there is a very important work still to be done; for the outer layer of the blastodermic membrane, which thus far has occupied all our attention, has made only the outer parts of the embryo. Our tadpole has a back-bone and a brain, it is true; he has skin, too, and muscles and eyes and ears, and is a very satisfactory tadpole — to look at; but when he leaves the egg what is to become of him without a stomach? And what will he do without a heart, and without lungs and kidneys and liver, and all those organs necessary to an animal whose food is no longer a part of him? We have been so intently watching the outer layer of the blastodermic membrane make the outside of the embryo, that we have failed to notice how the inner layer was just as silently and surely forming cells in exact places to form the internal organs of the creature. Let us look again

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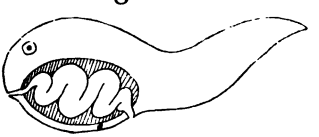
at our tadpole, and do justice to the work the inner layer has done, and we shall find that he has a stomach. It has been building cell by cell from the inner layer, while the skin, skeleton, and other organs were building from the outer layer.

At first his stomach was so large as to fill nearly the whole abdominal cavity, and he had no mouth for receiving food; and if he had had one it would have availed him little, for there was no opening at the other end of the digestive canal for the escape of food refuse. But the cells were equal to this emergency, for some of those in the outer layer of the blastodermic membrane died away and left an opening at either end of the digestive canal, and the digestive canal itself grew so long from the addition of cells from the inner layer of the blastodermic membrane that it could not lie straight but had to curl up. Moreover, cells from



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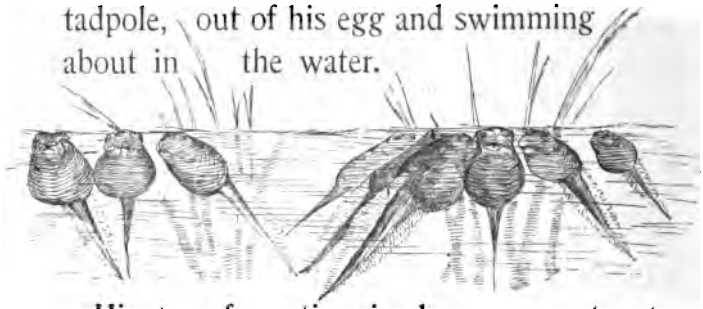
the inner layer of the blastodermic membrane built themselves into a heart and blood-vessels, and into the other organs necessary to tadpole life; and here is our tadpole, out of his egg and swimming about in the water.



His transformation is, however, not yet complete, for he is now in the fish stage. He is, in reality, a fish, swimming with a tail and breathing by gills. He must go one step farther, — get lungs and legs and become a land animal. Such changes in other animals take place in the egg, but with the tadpole the last great transformation takes place after he leaves the egg. The cells, still active within him, have already built the beginnings of lungs and legs; and before long, as every one knows

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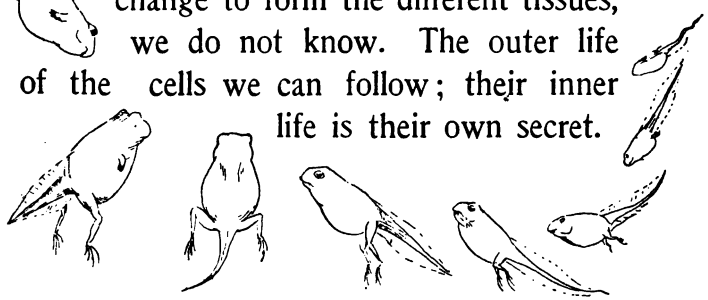
who has watched a tadpole change into a frog, the legs come out, — first the hind-legs, then the fore-legs. At the same time the tail and gills shrink away, the lungs form cell by cell, until finally tail and gills are quite gone, legs and lungs are fully formed, and the tadpole is transformed from a fish into a frog.

And now have we the secret of the blastodermic membrane in the frog's egg? No more than we have the secret of the artist when we watch him put his creations on canvas. We see the work done by the cells, — we may even see the cells at work; but why one forms bone, another muscle, another brain, or how the different cells change to form the different tissues, we do not know. The outer life of the cells we can follow; their inner life is their own secret.



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Wherever we examine the developing egg we find it travelling the same high-road as that travelled by the tadpole. The changes in the fish's egg are so like those in the frog's egg that the wonder is they ever find out which they are to become. In some fish eggs the blastodermic membrane does not close closely about the body of the embryo, as it does in the frog, but hangs loosely in a sac which is filled with the food-yelk, so that this yelk is partly inside the fish and partly outside,

as you can see in any stream in the springtime where fish eggs are hatching. This yelk is gradually absorbed into the body, and affords nourishment for the young fish until he is able to provide food for himself. This failure of the blastodermic membrane to enclose the yelk, and the consequent forming of the yelk sac, is common in all the higher forms of egg development.

And now for the mystery of higher life.

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If we watch the transformation of the bird's egg, we see it first pass through changes similar to those early ones passed through by the eggs of the fish and the frog; and as though that were not strange enough, we are filled with wonder to find that the creature forming in the bird's egg shows gill openings. Surely this egg has made a mistake, and is about to develop into a monstrous fish! But no. The cells know well that this egg cannot become a fish; they but do a moment's homage to the humble ancestors of the bright form they are about to perfect. "Once, way, way back in the world's history," they seem to say, "in those ancient times when change was possible, there were no birds; there were only fish-like creatures which were like birds and like fish, and from whom our pretty bird's ancestors were descended; and we would not have him, in his pride of flight, forget his relationship to these humble creatures."

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And so the cells build the old ancestral fish form as a foundation for the higher bird form, knowing that these gill openings are the best beginnings for beak and other bird parts; and that the cells of the outer layer of the blastodermic membrane can conduct the easily guided form safely past the fish stage, while the inner layer can as safely conduct the internal organs past the fish stage, — moulding the air-bladder into lungs, dividing the heart into four chambers instead of leaving it in two, and attending to the numerous other details that separate the structure of the bird from that of the fish. Thus we see how, as the egg develops, a time comes when the little creature seems on the verge of becoming a fish. It is more like a fish than anything else. Why does it not stop there and finish into a fish? An "obscure love" hurries it on, — gives it life and strength to pass the road down which the fish must turn. Its vitality is

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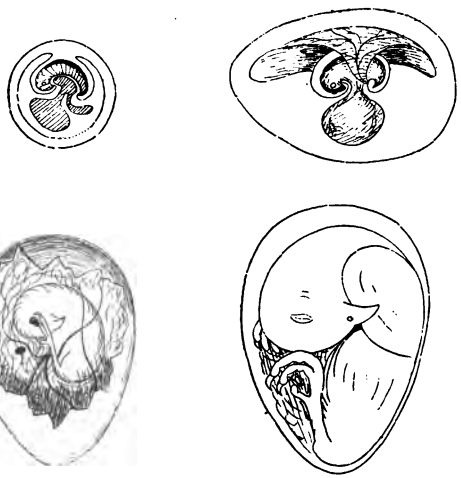
too great to be compressed into the limits of fish life; it must go on until it finds its parent.

In anticipation of the greater work to be done by the bird embryo, the bird's egg was more carefully fertilized and guarded than were the eggs of frog and fish. We now see how much more work the egg-cells must do to complete the bird. The following series of pictures shows some of the successive changes that appear in the bird's egg.



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If the egg belongs to a creature still higher in the scale of animal life than do those eggs we have watched, we find it going through the same changes, and its embryo developing through stage after stage similar to those passed through by the animals below it. The mammal begins life as one cell, like the lowly moneron. Impressed with the desire to grow, it becomes a creature like the worm. It scarcely pauses at that point, however, there is such a powerful impulse hurrying it along the high-road of life. It passes stage after stage in quick succession; it has the gill openings that belong to the embryo of the fish, but it has the life of the mammal, — it must become a cat, a horse, a dog; and so its gill openings become the foundation of the lower jaw and ear. Each embryo, intent upon its own form, hastens toward the goal; each acquires by degrees the organs peculiar to its kind.

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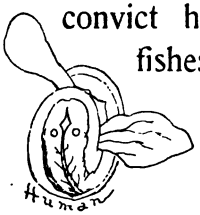
Although all are mammals, and all are built on the same general plan, the cells of each know exactly where that plan is to be modified. The cells of the rabbit never fail to make long hind legs, and teeth suitable for gnawing. The cells of the dog never fail to make teeth sharp and strong, and of the peculiar shape and size that characterize flesh-eating animals. More than this, every cell in the rabbit is a rabbit cell, and every cell in the dog is a dog cell, — each kind making hide, hair, form, intellect, everything about its own animal characteristic of rabbit or dog, and different from every other animal.

And the human being, too, begins life as a single cell. He, too, passes through stage after stage of animal life, owning a far-away relationship to the simple creatures he so far outstrips. Gill openings convict him, too, of kinship with the fishes; and he passes through a stage where, from one



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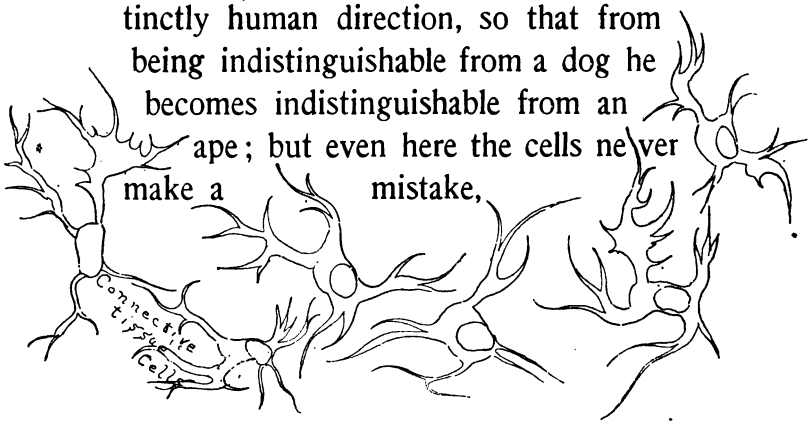
point of view, he looks absurdly like the embryo of a fish. But the strong wave of life bears him speedily past that point, and carries him toward the plane of the mammal. And for a time we find him in a very unsatisfactory state, neither bird nor yet beast; though with his undeveloped heart and budding extremities he more resembles the young bird than any other animal. On he sweeps to the true mammalian form, and there passes through a stage which all mammals share with him. Here he cannot be distinguished from an embryo pig or dog. But he does not long continue to so closely resemble these lower forms; his cells work away in a distinctly human direction, so that from being indistinguishable from a dog he becomes indistinguishable from an ape; but even here the cells never make a mistake,



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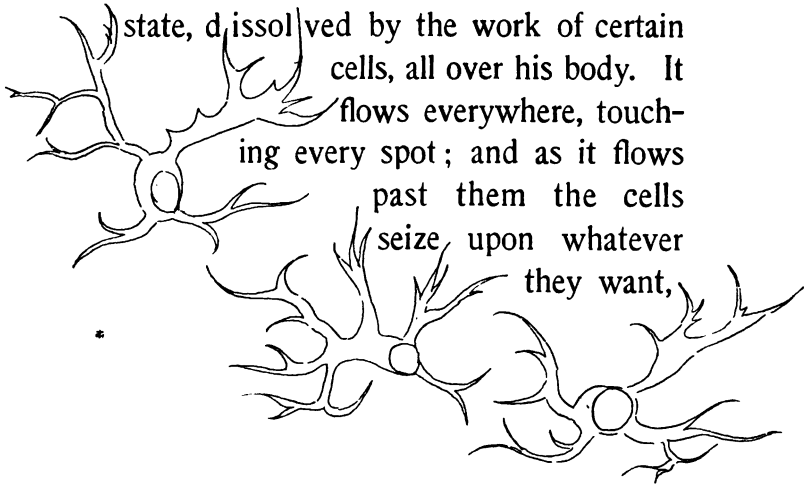
never grow confused and finish him into an ape, but keep steadily at work until he is built into a human being.

When his form is sufficiently developed, he, like other mammals, is born. This does not mean that his cells have accomplished their work. Far from it,—his cells are as busy as ever. They fasten upon the milk he drinks and form it into themselves; the muscle cells turn it into muscle, the bone cells into bone, the brain cells into brain. Later, when he eats solid food, the cells seize upon that. His blood carries his food in a dissolved state, dissolved by the work of certain cells, all over his body. It flows everywhere, touching every spot; and as it flows past them the cells seize upon whatever they want,



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to make new tissue or replace that which is worn out.

Thus the body is dependent upon the cells as long as it lives. When the cells cease their work the body is dead. The cells are dependent upon the food they get for the kind of work they can do. At first milk supplies all that is needful; then comes a more varied diet, — vegetables, fruits, grains, and meats being taxed to supply the never-ceasing cry of the cells for food. Nerve cells in the mouth and nose test this food and decide upon its merit.

But these nerve cells are better pleased with some things than others; the nerve of taste rejoices in sugar and certain combinations of flour and butter called pastry, and certain stimulating spices. To a limited extent such food is proper; but because it "tastes good" the ignorant feeder eats it to the exclusion of other foods which are more digestible, — and finally

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the cells of the stomach, overworked and weak, refuse to dispose of the indigestible stuff. Although warned by the uncomfortable feeling caused by the rebellious cells, the victim sometimes continues to transgress.

What is the result? The cells refuse to do their work; they grow sullen and irritable; and the food in an undigested state is turned out of the stomach. The blood cannot get the materials that it needs for this ill-prepared food, and of course the cells cannot get what they need from the blood. Some of the cells starve to death; others do their best, but the tissue they build is weak and flabby. Others again, not able to build what they wish, take the poor material and build another kind of tissue, which being unnatural, does all sorts of mischief in the body. All of the cells are discontented and sick, and allow the germs of foul diseases to lodge in their midst, if such germs appear and

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ask admission. The brain cells, being poorly nourished, are irritable, and cause all sorts of suffering in the way of headache and nervousness to the victim. The skin cells do not trouble to build up good skin; but when the old falls off, there is a bare and sore spot underneath.

Everything seems out of order, and the victim of this careless treatment of the cells is told by the doctor that he has dyspepsia; and he thinks dyspepsia is a stomach trouble, when it is really the starvation of the cells all over his body. The cells, like the people they are a part of, form habits. When the stomach cells have formed a habit of not performing the work of digestion, this habit grows upon them; so while the young person may not suffer seriously from a careless habit of eating, he is laying up terrible trouble for future years.

The use of tobacco has a curious effect upon the cells of the body. The nerve

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cells feel it first. When tobacco is first smoked to excess the cells resent it with all their might. The stomach cells often become violent and force the contents of the stomach out through the mouth, but after a while the cells become demoralized; the overdoses of tobacco deaden them and thus relieve the discomfort at first caused. This is probably the reason they seem to crave it. They want the thing that poisoned them to poison them more, and so deaden their discomfort.

Tobacco is very irritating to some cells, while it is soothing, or deadening, to others; and so, when used to excess, it sometimes causes incurable ulcers in throat and mouth. The cells, finding that they cannot make good mucous membrane in the presence of tobacco poison, make pus cells instead. The senses grow less acute under the influence of tobacco, until those of taste and smell are dull, and the victim can no longer enjoy the odor of the but-

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tercups and daisies when he walks in the fields, and probably comes to prefer the stale tobacco odor which he constantly carries about with him to anything the sweet fields can offer.

The cells of the body are very sympathetic, as we thus see. Ready to do good work if properly treated, they are very apt to unite against oppression if ill-treated; so that harm done to even a few cells will often affect the whole body. Of all the abuses to which the cells are subjected none is more harmful than the habit some people contract of poisoning them with alcohol. At first the alcohol stimulates certain nerve cells, and this causes a feeling of pleasure. But if the alcohol has been taken in excess the pleasurable feeling soon passes, and then the cells are weak and weary. Whenever they are thus overexcited an abnormal action is set up. Like the cells irritated by tobacco, those poisoned by alcohol crave more of the

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poison to make them forget their discomfort; so the victim is led on by slow but fatal steps until his cells are thoroughly demoralized and will do nothing right. The stomach cells refuse to act, the food is not properly digested, and after a time the inside of the stomach becomes covered with sores. The cells that ought to make liver go to making fat instead. In fact, the cells all over the body seem to have lost all moral rectitude, and instead of building up sound tissue, take a drunken delight in converting the alcohol-saturated blood that comes to them into all sorts of abnormal tissue; until finally the victim dies of some terrible disease with which his wine or beer drinking had apparently nothing to do, but which was really at the bottom of the whole trouble.

And what do we mean by dying? What is this thing named death? What becomes of the body when it is buried; of the flower when it falls; of the plant

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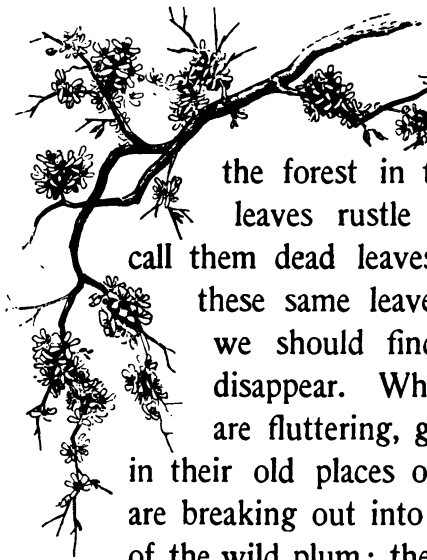

when it has done its work? Walk through the forest in the autumn; the dry leaves rustle under foot and we call them dead leaves. Could we watch these same leaves from year to year we should find that in time they disappear. Where are they? They are fluttering, green and full of sap, in their old places on the trees; they are breaking out into the white bloom of the wild plum; they are throbbing in the heart of the wood-pigeon, and painting the sky with sunset colors.

When the leaves fell it seemed a misfortune, and those who used concerning them the dread word death did not know that they had but completed one beautiful form of life, and become free to enter into another. The carbon, hydrogen, oxygen, nitrogen, and other elements that had been so long bound into

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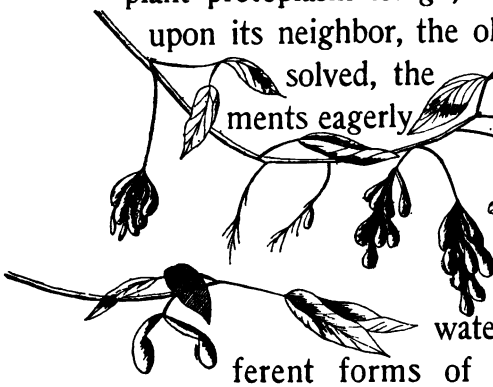

plant protoplasm let go, each one, its hold upon its neighbor, the old bond was dissolved, the freed elements eagerly formed new combinations. Our leaf is now a quantity of water, ammonia, different forms of lime, magnesia, potash, soda, acids of various kinds, and combinations of iron, as well as many other substances. Behold our leaf returned to the mineral kingdom. Though not wholly. Certain of its elements enter at once into lowly forms of vegetable life, which are lying ready to seize upon them and develop waiting spores into growing life; and still others find their way at once into the animal life.

The leaf now finds itself in a myriad of forms, and distributes itself through life. The ammonia, the ashes, sink into the

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ground, and are wooed by the rootlets of the forest trees to ascend through the branches and unite with the living tissue in the buds to form next year's leaves. The rootlets of the wild grape eagerly seek the aid of these wandering leaf elements, that its branches may be clothed with verdure; the wild rose would have a share; the burdock, too, and the wood anemone wish to attract them; the birds and the insects appropriate the fruit they have gone to form; their vapor, rising through the air and condensing into clouds, adorns the blue sky and reflects the sunset hues.

And yet men talk of dead leaves, — call them dead because they would leave a stiff triangle of wood fibre and green tissue to mingle with the universe!

Thus, too, with the bird. One day it

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lies down and rises no more, and men would have us believe it is dead. The spirit that bound its countless cells into one harmonious whole has loosed the bond; the bird's body—its immortal body —is now free to enter other forms of life. Like the cells of the fallen leaf, the cells of the fallen bird dissolve,—they free the elements which formed them; and these elements, quite unchanged by their long captivity, joyously greet the change, enter into new and delightful combinations, and lo! our whilom bird is now a lovely bit of vegetable life,—the same atoms of carbon, hydrogen, oxygen, nitrogen, and sulphur which formed his protoplasm being happily united into the new protoplasm of the plant. Every atom of the pretty bird's body is somewhere in Nature, active as ever,—helping the flowers to bloom, the birds to sing, the bees to store up honey, the deer to run, and the little mouse to hide.

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We thus see that when a body dies it is not destroyed, it but changes its form. Its countless cells, composed of the elements gathered from the air and from food, are now about to give up those elements, but not the smallest atom can be lost. Each one will be but freed to seek a new life according to its surroundings and its nature. The all-powerful principle of life but rearranges its cells to express life in other ways. The spirit, having clothed itself in a finite form, which for a time it wore, has at length restored that form to the elements from which, cell by cell, it called it forth. The spirit, no longer needing the cell-built body, releases it, and the body finds its place in a new form of life.

The immortal spirit, free from the cell-built body, clothes itself in what unknown glory!

The immortal body, free from the controlling spirit which held it in a definite

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form, is shaped into what forms of wonder and beauty!

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